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Power Plant at Fort Sill

LIGHT, REFRIGERATION AND HEAT FURNISHED TO ARMY BY MODERN PLANT BURNING FUEL OIL. BY IRVIN O. MONTGOMERY

AT FORT SILL, OKLA., the United States Government maintains a power plant of considerable size consisting of 3 departments: the lighting plant, the refrigerating plant and the heating plant.

The lighting system is 2300-v. 3-phase, and installed in the lighting plant are the following:—2 55-kw. rotary valve Ridgway Dynamo & Engine Co. alternators, direct connected to 2 75-hp. by the Ridgway Dynamo & Engine Co. Belt connected to each of the above, is a 7½-kw., 70—125-v. Thompson-Ryan dynamo, as exciters.

Two small units alternate daily on the non-peak load, while the large unit is run during the peak load every evening, and, during the winter, it is run about 2 hr. in the morning. All 3 engines are equipped with Schutte & Koerting automatic and remote stops.

The switchboard was built by the Westinghouse E.

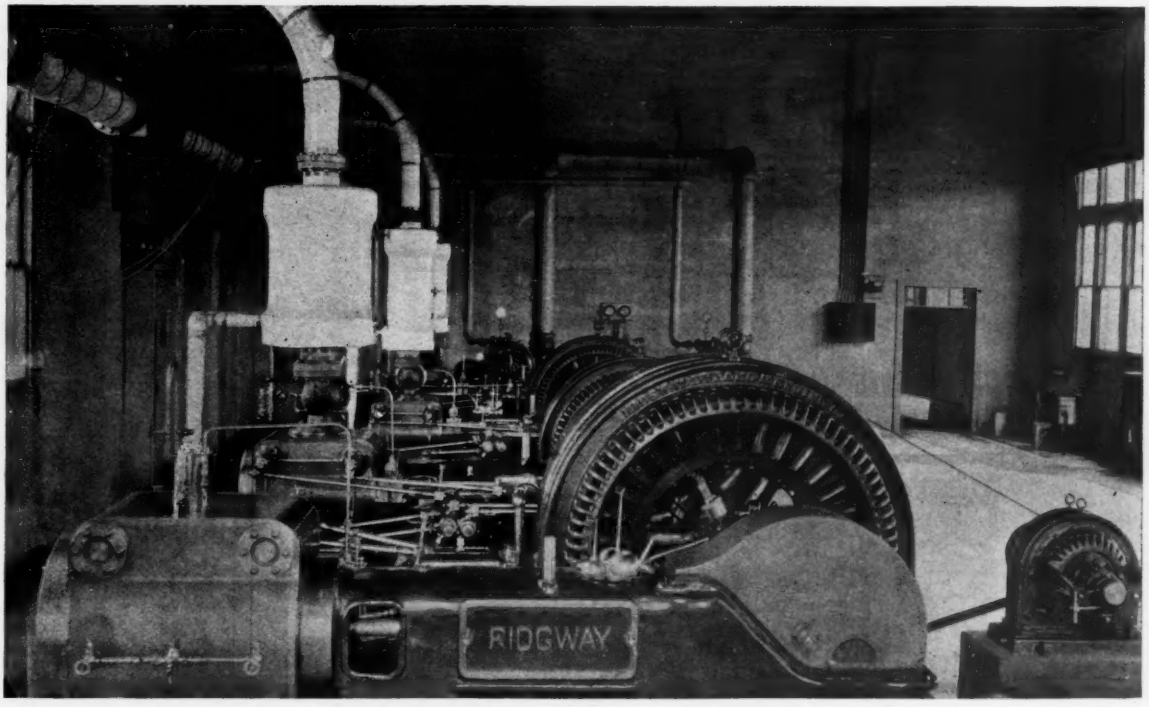


FIG. 1. ENGINES AND GENERATORS IN FT. SILL PLANT

10½ by 12-in. engines of the same make, running at 275 r.p.m., 1 110-kw. alternator, direct connected between the cranks of a 150-hp. cross compound engine, 13 and 19 by 16 in., which runs 225 r.p.m., also built & M. Co., and consists of 3 generator panels, each of which has an ammeter on each phase; a 3-phase indicating wattmeter, showing the total load on the generator; a d.c. ammeter; and main, field and exciter

switches, time limit relays, synchronoscope receptacle, d. c. voltmeter receptacle, rheostats, etc.; one panel which carries the power and lighting bus connecting switch, and the switch controlling the interior lights, with a wattmeter on each phase, and an integrating wattmeter; one panel which carries the switches controlling the 2 remote control electric pumps, with a wattmeter on each phase and an integrating wattmeter on each

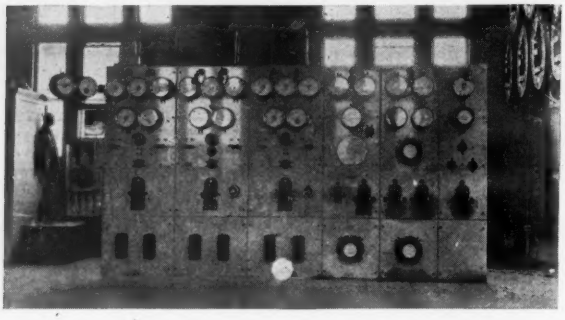


FIG. 2. SWITCHBOARD GIVES RECORD OF CURRENT DISTRIBUTION

circuit; and one panel which carries the plugs and switch for the street lights, with an ammeter and an integrating wattmeter.

On the street lighting circuit, there are 104 25-v. 80 candlepower street lights with Edison Mogul sockets and film cutouts, regulated by a 10-kw., 2500-v. constant-current transformer.

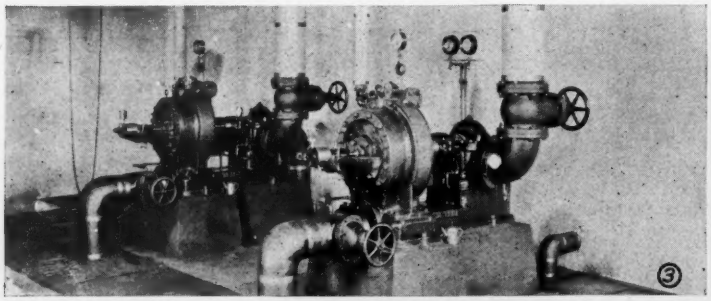
There are in use in the Post about 4500 lights, about half of which are 50-watt Gems, while the rest are from 100 to 10-watt Mazdas.

Water is pumped by a Deane Steam Pump Co. triplex pump, 8½ by 10 in. driven by a G. E. Co. 3-phase, 440-v., 50-hp. slip ring motor (Model M). The motor is controlled by a G. E. Co. contactor panel, and may be started or stopped from the power plant, which is one mile away. The water is pumped from 3 wells, about 30 ft. deep, and what is known as the Ambrosia spring, into which a gallery, running about 500 ft., empties. The pump works ordinarily under a head of about 88 lb., and is rated at 300 g.p.m.

Water is pumped through an 8-in. cast-iron main, to the 500,000-gal. concrete reservoir, where it is stored until needed, which, by the way, is not long, as the average report shows. During the month of May, the pump was run on the average of 23 2/3 hr. a day, and every day in the month, being shut down long enough to be wiped and oiled once a day.

Besides this, we have a 525-g.p.m., centrifugal pump, direct connected to a 3-phase, 220-v., 30-hp., Westinghouse motor, connected to a tap in the main that supplies the city of Lawton, Okla. This is also a remote control motor, operated from the Power Plant. Ordinarily the pressure on this main is sufficient to put the water in our reservoir without using the pump, and it is bypassed around it, and the pump is used only for fire purposes. The pressure on the system averages about 50 lb., but can be raised as needed by manipulating valves, and pumping directly into the mains.

Distribution is overhead, on 5-ft. wooden poles, with 2300 v. on the primaries, which is stepped down to 220-v., 3-wire secondaries, which run into the buildings. The transformers are grouped to balance the system fairly well, when the street lights are not burning, which is all that can be done, as the street lights are run on a moonlight schedule.



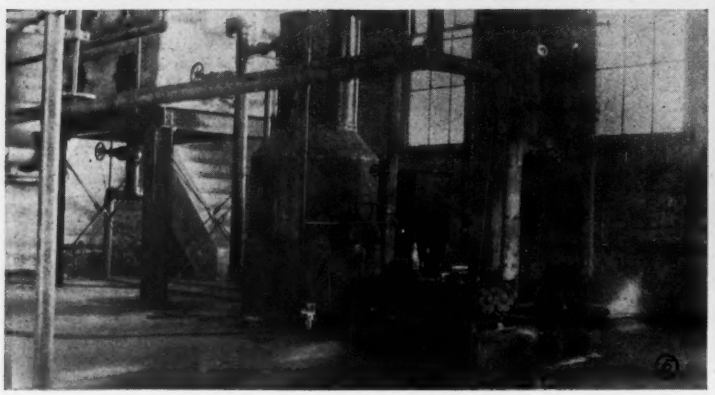


FIG. 3. CIRCULATING PUMPS FOR HEATING SYSTEM

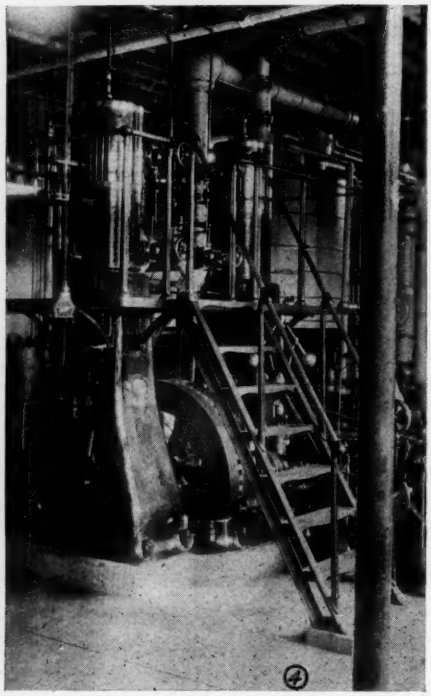


FIG. 4. AMMONIA COMPRESSOR

FIG. 5. FEED PUMPS AND WATER WEIGHER

The refrigerating plant is rated at 10 tons, but 7 cold storage rooms take about 4 tons daily, leaving the ice output of 6 tons which is taxed pretty heavily during the very hot weather. The freezing tank is built for 130 200-lb. cans. The brine system is used, and the brine is kept at about 25 deg. Baume. Calcium chloride is used for the brine. The compressor is a York upright, 34-hp. About 4 tons of ice a day are pulled, and the compressor is run about 16 hr. a day. Distilled water is used for making ice, being procured by condensing the exhaust steam from the compressor engine, with a connection to the exhaust of the engines in the lighting plant, if necessary. The condensate is reboiled and skimmed, making nice clear ice.

The water for the hot water heating system is heated, when the temperature stands above 45 deg., by exhaust steam, but when it is colder, a live steam heater is used. The water is circulated by De Laval 8-in. turbine pumps, the expansion tank being located in the plant, and about 45 lb. pressure is kept on it by a Westinghouse air pump. There is about 45,000 sq. ft. of radiating surface, about 2/3 of which is direct, the rest direct-indirect.

About 22,000 ft. of pipe, ranging from 9-in. mains to 2-in. branch are laid in concrete duct, covered with magnesia pipe covering.

About 400 hp. is required for the operation of this system, during the cold weather. It was installed by the Evans-Almirall Co., at a cost of about $70,000.

been ordered. The feed water is heated by a Cochrane feed-water heater and purifier, and is weighed as it goes to the boilers by a Wilcox automatic liquid weigher. The feed water enters the boiler at 210 deg. during the time the exhaust is not being used in the heating system, and averages about 165 deg. when it is used. The feed pumps are Worthington outside end packed duplex.

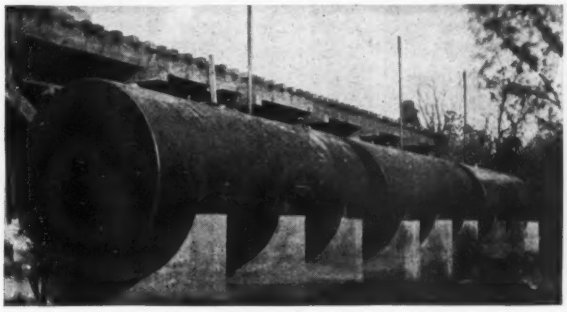
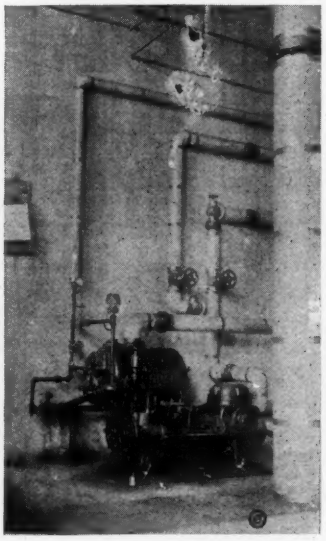


FIG. 7. FUEL OIL STORAGE TANKS

Fuel oil is burned in the boilers at a gravity of about 90; specifications call for the gravity to be between 85 and 97, flash point not below 60 deg. C., must flow at 0 C., and have a heat value not below 18,000 B.t.u.'s. The heat value averages about 19,500 B.t.u.'s per pound. The oil is fed to the boilers by Worthington 3 by 2 by 3-in. duplex piston pumps, through a meter,



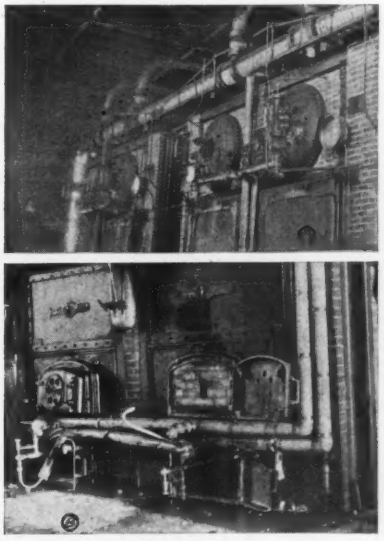


FIG. 6. CONDENSATE PUMPS AND TRAP FROM LIVE STEAM HEATER

FIG. 8. A. PORTION OF BOILER FRONTS SHOWING FEED-WATER REGULATORS. B. PIPING TO OIL BURNERS

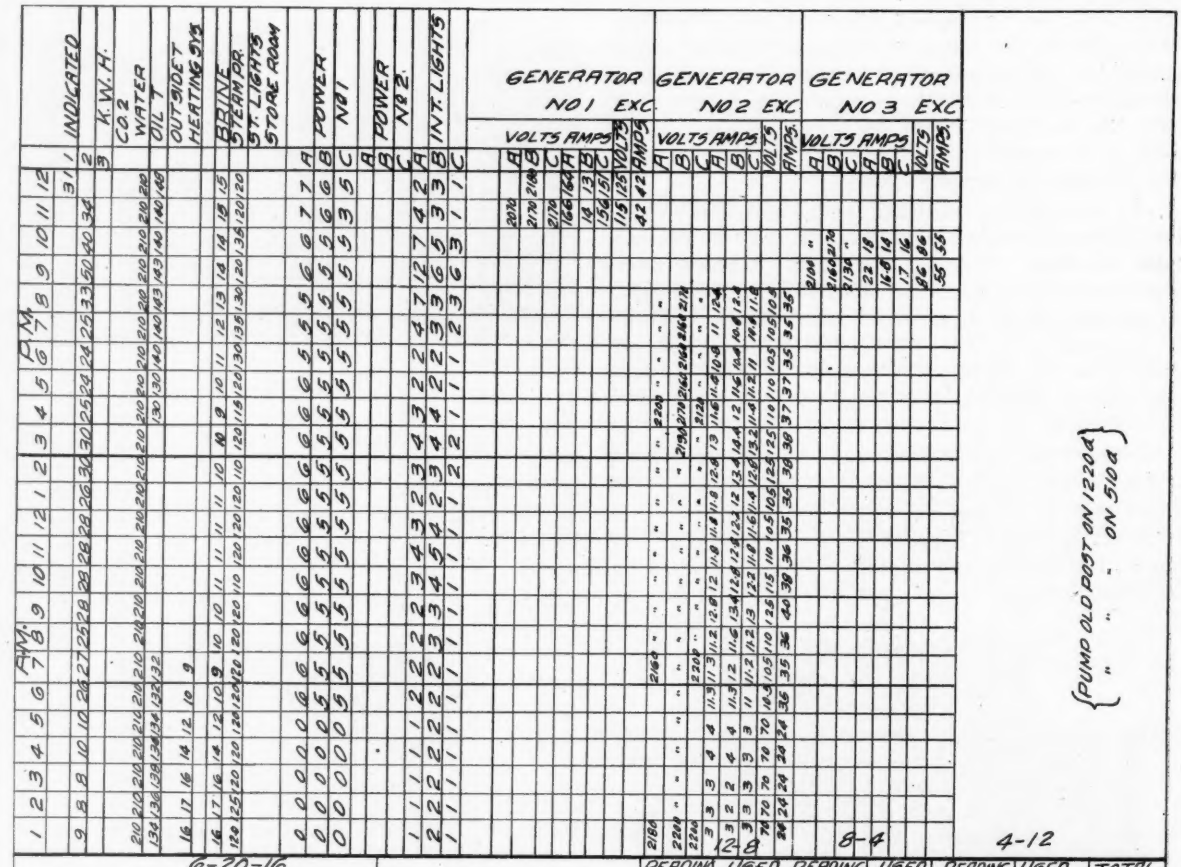
The steam for the above plants is furnished by 4 150-hp. Babcock and Wilcox water-tube boilers, which are equipped with Copes feed water regulators, and an automatic CO_2 and draft recorder, so connected that the gas may be taken from the third passage of any or all of the boilers. This instrument is not in operation at present, being the third one of this make manufactured, and while it may be of value as a curio, its practical value in the plant is nil; however, a new one has

and at a temperature of about 135, and a pressure of about 50 lb. Peabody oil burners are used in the furnaces.

The boilers are run for 30 days, then opened and washed and the Lagonda tube cleaner run through the the 3 bottom rows of tubes, and one of the other rows, the top rows being taken in turn, and once each year, each boiler is thoroughly cleaned and overhauled. Nothing is used in the boilers but graphite, this giving excel-

lent results. The water used in the boilers is taken from the post mains, and is practically the same as filtered surface water. Soda ash was formerly used here, and much trouble was blamed on it, especially in the gaskets, and, as it seemed unnecessary, its use was discontinued. Since then, there has been practically no gasket trouble in the entire plant, and the boilers are in better condition than before. In the last year, and with the completion of the work going on at present, every gasket will have been renewed.

A 5-in. auxiliary header has been installed and, with some changes in the location of some of the valves, and



6-20-16				READING	USED	READING	USED	READING	USED	TOTAL
INTERIOR LIGHTS	START	STOP	WATER WEIGHER	45282	32	45314	92	45406	73	
POWER No 1	5:10 A	12:20 A	OIL METER	712722	309	713031	377	713408	276	
" " 2			INTERIOR LIGHTS	362758	56	362814	80	362894	109	
ST. LIGHTS	8:35 P		POWER No 1	172605	38	172643	112	172755	114	
GENERATOR No 1	10:50 P		" " 2	32024	21	32045	22	32067	10	
" " 2		8:10 P	ST. LIGHTS	87240	1	87241	0	87241	30	
" " 3	8:10 P	10:50 P	RETURN PUMP	3097	11	3108	20	3128	3	
LIVE STEAM			HOUSE PUMP	7360	9	7369	0	7369	6	
AMMO. COMP.	200 A	5:00 P	ICE PULLED	NO		40		NO		
REBOILER	300 A	5:00 P	TUBES BLOWN	NO		40		NO		
BRINE PUMP	OPERATING		BLOWN DOWN	YES		YES		YES		
AIR "			POP VALVES TESTED	YES		YES		YES		
RETURN "	300 A	5:00 P	ENGINEER							
BOILER No 1	OPERATING		FIREMAN							
" " 2			OILER							
" " 3			STEAM FITTER							
" " 4			ICE PULLER							
FEED PUMP No 1	OPERATING		LABORER							
" " 2										
OIL " 1	OPERATING									
" " 2										

FIG. 9. REPORT FORM SHOWING DAILY RESULTS

the installation of a new one in the old piping, it has been so arranged that any part of the line may be repaired without seriously interfering with the operation of any important part of the plant. An auxiliary feed line has been installed, and with the removal, from another plant, and the overhauling of an old Blake-Knowles duplex piston 6 by 6 by 10-in. pump, this plant will be well guarded against a shutdown from failure of any one part of it.

TYPICAL MONTHLY REPORT

POWER PLANT

FORT SILL, OKLAHOMA, U. S.

June 1, 1916.

REPORT OF OPERATION, COST OF PRODUCTS, ETC., FOR MAY 1916.

Interior Lights	9298	
Street Lights	1709	
Power for pumping	11575	
Total Electricity	22582	KWH
Average Daily	729	
Refrigeration, tons daily	225	
Average	7.2	
Ice, tons	91	
Water, pumped, gallons	12122850	Gallons
Average, Gallons Daily	391040	"
Oil for Interior Lights	7930	"
Oil for Street Lights	1243	"
Oil for pumping	9623	"
Oil for Electricity	18796	"
Oil for Refrigeration	9315	"
Oil for Saw Mill	143	"
Oil for Heating	2407	"
Total Oil For Month	30661	Gallons
Average daily	981	"
Oil per K.W.H., gal.	.84	
Oil per ton, Refrigeration, gal.	41.4	
Oil per 1000 feet, Radiation, per day, gal.	12.9	
Oil per H.P., gal.	.33	
Oil per 1000 pounds, Steam, gal.	9.63	
Watts per 1000 gallons water, pumped	830.	
Water, evaporated, lbs.	3182700.	
Average daily	106668.	
Water evaporated per pound oil	14.4	
Boiler H.P. hr. developed	93609.	
Average H.P. per boiler per hour	125.8	
Percent rated load on boilers	83.8	
Boiler efficiency, per cent	72.7	
Cost of oil for month	$582.55	
Cost of supplies for month	51.49	
Cost of repairs for month	8.00	
Labor for month	440.00	
TOTAL COST FOR MONTH	$1082.04	
Cost of electricity per K.W. hour	.0269	
Cost of Ice per ton	1.93	
Cost of Ice per cwt	.096	
Cost of Heat per 1000 ft. Rad. per day	.372	
Cost per H.P. hour	.0116	
Cost per 1000 lb. Steam	.34	
Cost of water per 1000 gallons	.0223	

James V. Montgomery
Master Electrician, Q.M. Corps,
In Charge of Plant.

The force consist of a master electrician, quartermaster corps, who is in charge of the plant, the lighting system, and the water supply system; the chief engineer, who is a sergeant in the quartermaster corps, and who is permanently on duty from 8 a. m. to 4 p. m.; 2 civil service engineers, who alternate monthly on the night watches; an oiler, who is a private, first class, quartermaster corps, who looks after the oiling and the taking of readings, etc., on the day watch, and relieves an engineer or fireman who wants off for one or more watches; one civil service and 2 privates, first class, quartermaster corps, firemen; one ice puller, private, quartermaster corps, and one steam fitter, private, first class, quartermaster corps, who also looks after the heating system. All the above men are enlisted men except the 3 mentioned. Besides these, there is a sergeant first class, and a private, first class, quartermaster corps, who do the repair work on the lighting system outside of the plant, and look after the electric pumps, etc., on the water system.

The report herewith is submitted to the quartermaster on the first day of the succeeding month, and the log sheet is kept in the plant.

Allowance of fuel is based on the water evaporated, and this report shows a consumption a little better than the allowance, which amounts to about 14.1 lb. of water per pound of oil.

The log sheet was gotten up after long study of the conditions of the plant, and while there is still room for improvements, it covers the purpose fairly well. The sheet was hurried a little, however, on account of our CO_2 recorder going out of commission, and of course our evaporation tumbled at the same time, so something had to be done. The log sheet gives the results obtained by each fireman and created a friendly competition on their part, and raised the evaporation from 12.9 to 14.4.

This was accomplished by paying strict attention to the position of the dampers with the varying loads, which is about all there is to firing fuel oil.

Costs of products figure lower in this plant than they would with the same efficiency on the outside, as some of the overhead charges, including depreciation, insurance, taxes, and interest are not figured in here. The pay of all the men named was considered; but in the case of enlisted men, there are certain allowances of which it is hard to figure the money value.

The total cost of the plant was about $200,000.

RUMOR HAS IT that a consolidation of 12 large valve and hydrant manufacturers is under way, meetings to discuss the matter having been held in Cincinnati, O., Troy, N. Y., and Springfield, Mass. Among the firms said to be taking part are Chapman Valve Mfg. Co., Pratt & Cady Co., Flower-Stephens Mfg. Co., Kennedy Valve Mfg. Co., and Ludlow Valve Mfg. Co. Extension of trade in South America is one of the important objects.

U. S. CIVIL SERVICE COMMISSION announces an examination for junior structural steel draftsman, to fill vacancies in the Bureau of Yards and Docks, Navy Department, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications in the Department or in the Navy Yard Service throughout the United States, at salaries ranging from $3.52 to $4 a day. Competitors will not be assembled for examination, but will be rated on physical ability, education and preliminary training, and must have had (*a*) the equivalent of a high-school education and 3 yr. of experience in structural steel design and construction, or (*b*) a degree in engineering from a school of recognized standing; they must have reached their twentieth birthday on the date of making oath to the application. Apply for Form 1312.

Lubrication of Steam Engine Cylinders

SELECTION OF PROPER LUBRICANT FOR VARIOUS CONDITIONS; METHODS OF FEEDING. BY JOHN ROME BATTLE*

THERE is no more important engineering supply bought for use in power plants and mills than the lubricants used on the machinery, and yet the intelligent purchase and application of lubricants is a subject about which very little is known by the operating engineer and mechanical superintendent.

Lubricating engineering is a new branch of the engineering profession, which deals with the selection, application and testing of machinery lubricants. There is an almost unlimited field for the development of this important science and the results that reward its use are so evident that all operating engineers and others familiar with the operation of machinery should co-operate with the manufacturers of lubricants, in a concerted effort to standardize the subject.

It should be possible to buy lubrication with as much intelligence and knowledge as is available for the purchase of other engineering necessities. The choice of lubricants should be based on the results indicated by ultimate operating economy and engineering requirement, and should not be determined simply from the standpoint of the actual cost of the lubricants, as is the present average practice.

Standardization of lubricating engineering demands the accumulation and comparison of large amounts of practical data and experimental results, and in order to obtain the largest part of this material, the operating engineer must be encouraged to give consideration to the subject of practical engineering experiments to be conducted in his own plant.

Steam cylinder lubrication offers a wide field for study and experiment. In the following paragraphs I have tried to suggest and tabulate the conditions which directly and indirectly affect the process of this class of lubrication, with the object in mind of placing before the operating engineer an outline of the typical methods to be followed in conducting experiments in lubricating engineering in the average plant.

There are 3 general conditions affecting the operation of steam cylinder lubrication, namely:

1. The lubricant must perform its work in a more or less inaccessible place, which causes the determination of the quality of lubrication obtained to be difficult.

2. The lubricant must be indirectly applied to the surfaces requiring lubrication.

3. The condition of the cylinder walls and valve seats is decidedly unfavorable to receive the lubricant, due to their heated state and wet surface.

The general conditions, as outlined above, exist in every steam cylinder and must be considered when investigating this type of lubrication. These general conditions are directly affected by the following specific conditions:

1. The pressure of the steam supplied to the cylinder.
2. The piston speed.
3. The type of the engine.
4. The condition of the steam.
   (a) Saturated. Wet or Dry.
   (b) Superheated. Degree of Superheat.
5. The separator, its location and condition.
6. The distance of the engine from the boilers and the condition of the piping.
7. The method and effectiveness of feeding the lubricant. The effects and importance of the above specific conditions are considered in detail as follows:

*Author of Battle's Lubricating Engineer's Handbook.

PRESSURE OF THE STEAM

THE DETERMINATION of the steam pressure at the engine is important, because when it is known, reference can be made to a steam table and the temperature of the steam corresponding to that pressure can be obtained. This temperature fixes the heat conditions to which the lubricant is exposed, during the processes of atomization in the steam pipe and application to the surfaces requiring lubrication.

For the purposes of lubricating engineering, it is sufficient to consider a 5 per cent line loss in the steam pressure, between the boiler and the engine cylinder. Therefore, deduct 5 per cent from the pressure of the steam as indicated by the boiler gage, and refer this value to the steam table shown below, from which the temperature of the steam may be obtained.

STEAM TABLE

Steam Pressure (Gage)	Temperature in Fahrenheit Degrees
50 lb. per sq. in.	297*
70 lb. per sq. in.	316
90 lb. per sq. in.	331
110 lb. per sq. in.	344
130 lb. per sq. in.	355
150 lb. per sq. in.	365
180 lb. per sq. in.	379
200 lb. per sq. in.	387
250 lb. per sq. in.	405

Note—The temperatures are not exact, but are taken to the nearest full degree.

SATURATED STEAM

IN THE accompanying table it can be readily seen that the temperature of saturated steam, even at the high pressure of 250 lb. per sq. in. is only 405 deg. For this reason, it is not necessary to take into consideration the flash point of petroleum cylinder oils, that are to be used in cylinders supplied with saturated steam, as any oil made from a petroleum base for the purpose of steam cylinder lubrication, will have a flash point that is considerably higher than 405 deg.

Consideration must be given, however, to the effect of the steam temperature upon the atomizing operation of the oil, by the steam and the mixing of the oil with the steam, for the purpose of carrying it to surfaces requiring lubrication. The characteristic effect of temperature rise upon the physical property of the oil, known as its viscosity or body is an indication of the probable effectiveness of the atomizing operation.

By reference to the curves of temperatures and viscosities of several oils, having high, low and medium viscosities at the standard testing temperature of 212 deg. Fahrenheit, as shown in the Practical Reference Tables of this issue, it is evident that the low viscosity oil requires that its temperature be raised a much smaller amount, to cause its viscosity to be reduced to the point where the oil will be very fluid, than is required by the high viscosity oil to produce the same result.

The atomization of the oil admitted to the steam line is dependent upon the velocity with which the steam rushes past the feed nipple and the exposed oil, causing it to be broken into small particles of atomized spray. The degree of atomization, that is the fineness of the oil particles, is a factor depending upon the degree of fluidity of the oil. The thinner or more fluid the oil is, the more complete will be the resulting atomization for the same velocity of the steam. It is therefore possible to regulate the effectiveness of the atomizing operation, by changing the oil, so that a high or low viscosity oil is used according to the results desired to be obtained.

In the process of atomization, several conditions must be considered. First, the oil must be sufficiently atomized, so that it will form a fairly staple mechanical mixture with the steam, sufficient to cause it to be carried past the throttle valve and on to the valve seat and cylinder walls. Secondly, the atomization must not be so complete or fine that it will result in a large part of the oil being carried out by the steam to the exhaust, due to the effectiveness of the resulting mechanical mixture formed with the steam by the fine oil spray.

It is therefore desirable to select an oil having a viscosity sufficiently low at the normal testing temperature to cause its fluidity at the steam temperature to be reduced to that point, which will produce a well atomized but not too finely divided spray.

The working temperature of the steam must be first determined. Then an oil having a viscosity of, say, 65 or 75 Saybolt, as an average but not established standard, at about ¾ of this steam temperature should be selected. The most approved method of accomplishing this selection is to obtain a curve of viscosities at various temperatures, for the oil under consideration, similar to the curves referred to above.

It therefore follows, that the viscosity of the oil to be used for the lubrication of steam cylinders supplied with saturated steam should be proportional to the steam pressure. High pressures demanding high viscosities and low pressures low viscosities at the standard temperature of 212 deg. Fahrenheit, which has been chosen by the oil trade, as the temperature at which the viscosities of steam cylinder oils are compared.

As an example, for saturated steam of 180 to 250 lbs. pressure, an oil having 160 viscosity Saybolt at 212 deg. F. would generally give good results, all other conditions being normal. For steam of 85 to 100 lb. pressure, an oil having about 120 viscosity at 212 F. would be satisfactory.

No consideration is given at this point to the compounding of the oil with a fatty or emulsifying oil, as the question of atomization is directly affected only by the properties of the petroleum component of the lubricant.

If the atomization of the oil by the incoming steam is complete, the drops or large particles of oil will not be carried to the desired points, as they will strike against and cling to the exposed surfaces of the throttle valve and steam pipe, and incomplete lubrication will result.

If the cylinder walls and valve seats do not exhibit signs of good lubrication, and the method of feed and other factors are found to be satisfactory, the viscosity of the oil should be adjusted, either higher or lower, according to the conditions as above described.

Type of Engine

The type of engine indicates the valve motion and type of piston with which the engine is equipped.

A slide valve engine, with its back and forward, straight line valve travel, has a greater scraping effect to be overcome, than is met with in the valves of a Corliss engine. The Corliss engine, however, requires that the long lateral contact surfaces be lubricated during a rotative movement about the valve axis. There has been very little advance made in the investigation of this subject, and the amount of oil required by various types of engines, as well as the most approved type of feeds, rest for the most part upon the judgment of the engineer.

Piston Speed

Determination of the piston speed is of interest, because from it and the dimensions of the cylinder, it is possible to estimate the number of square feet of surface rubbed over by the piston, in a given length of time. If the amount of oil fed during that time is known, it is possible to figure the number of pints of oil required per 100,000 sq. ft. of rubbing surface. This result will indicate to an experienced man whether the cylinder is receiving too much or too little oil. This subject offers a large field for investigation and comparison. The operating engineer should tabulate the amounts of oil used per 100,000 sq. ft. of rubbing surface by the various engines under his care and compare these results with those obtained by other operating men.

The speed of the piston has an important effect upon the lubrication of a steam cylinder, because it directly affects the amount of condensation water occurring in the cylinder. For saturated steam, an engine having a low piston speed will have a greater amount of condensation water in its cylinder than will be met with in the cylinder of an engine, whose piston moves at a higher speed, when they are both supplied with the same quality of steam.

The amount of compound required to produce emulsification of the oil with the condensation water in the cylinder which will prevent the destruction of the film by the resulting washing effect, is therefore directly dependent upon the piston speed.

Condition of the Steam

Under the subject of condition of the steam consideration must be given to the determination of whether the steam is superheated or not. If the steam is superheated, little or no condensation water will form in the cylinder. If the steam is saturated there will be varying amounts of condensation water in the cylinder, and the amount will be directly affected by the following conditions:

1. The piston speed, as before described.
2. The condition and location of the separator.
3. The pressure and temperature of the steam.
4. The condition and pitch of the steam piping, and the distance of the engine from the boiler.

All of these conditions are discussed in other paragraphs.

In order to reduce the "washing effect" of the condensation water, due to the fact that petroleum oil will not mix with water, a small percentage of a saponifiable oil, usually an animal oil such as tallow oil, is mixed with the petroleum cylinder stock. The amount of compound required, depends upon the amount of water suspected to be in the cylinder, after the various conditions as outlined above have been considered.

For low pressure, wet steam conditions, the usual amount of compound required is about 10 per cent, while for normal saturated steam conditions, with no unusually long steam mains and a good separator, about 5 per cent of compound is recommended. The best compound for steam cylinder oil is acidless tallow oil, but some cheap oils are compounded with De Gras or wool grease. This compound is not desirable, because it tends to form cylinder deposits.

When superheated steam is supplied to the cylinder, little or no condensation water will be met with; but to offset this factor, there will be high temperatures to be considered.

The number of degrees of superheat should be determined and with the aid of the steam tables giving the temperature of saturated steam at the corresponding pressure, the temperature of the superheated steam may be approximated. As previously described, the most important part of cylinder lubrication depends upon the proper atomization of the oil. For the high temperatures met with in superheated steam, the viscosity of the cylinder oil must be high enough to begin with, to prevent it becoming too fluid and producing too fine an atomization when it is exposed to the superheated steam. The viscosity of a typical superheated steam cylinder oil, for steam of 175 lb. pressure and 75 deg. superheat, should be about 375 deg. Saybolt at 212 deg. F.

It is usually safest, to use an oil having as high a flashing point as it is possible to obtain, for these cylinders, but this factor is usually taken care of by the refining operation of the oil, as the high viscosity required of the oil carries with it a high flashing point.

Since the walls of the cylinders are practically dry, with superheated steam, there is no need for any outside compound being put into the oil.

The Location of the Separator

The location and condition of the separator have an important bearing upon the amount of moisture in the cylinder and also upon the occurrence of cylinder deposits.

In general, the separator should be located as near to the engine as is possible. This will allow the steam to enter the cylinder in as dry a condition as the efficiency of the separator and the quality of the steam will permit.

The steam piping should have a pitch towards the separator, to prevent the condensed water in the piping from flowing against the direction of steam flow, which will result in its being picked up by the steam and thus increase the amount of moisture to be removed by the separator.

If the separator is in bad condition, the cylinder will not only have a greater amount of water in it, but there will also be a considerable amount of solids carried over by the steam, which will not be caught by the separator and the tendency will be to cause cylinder deposits. The occurrence of cylinder deposits should always be followed by an examination of the separator.

The Method of Feeding the Lubricant

The method of feeding the lubricant to the steam line is one of the most important factors affecting cylinder lubrication, because unless this operation is correctly carried out, the oil will not be atomized, but will be carried by the steam in the form of drops, which will not reach the desired surfaces.

The oil feed pipe should enter the steam line at a point that is at least 3 ft. above the throttle valve. The atomizing nipple should be slotted on the top or side, and should be closed at the end. It should be inserted into the steam line, so that the end will extend just past the center of the steam pipe. If the nipple is screwed into the pipe, so that the end is flush with the inner surface of the pipe, the oil will cling to it and will run down onto the throttle valve.

If the hydrostatic type of lubricator is used, the joints of its piping must be kept tight, to prevent uneven feeding. The lubricator must be kept well filled to prevent foaming.

The top connecting pipe, or, condensing pipe as it is called, of a quart sized lubricator should be at least 5 ft. in length.

When a forced feed lubricator is used, the measuring pump must be adjusted, so that it will feed a sufficient amount of oil. Usually, it has been found that these lubricators are adjusted to supply entirely too little oil, due to an effort to show an unusual economy of oil required by the cylinder, when this type of lubricator is used.

The forced feed lubricator has many advantages, the chief one being the automatic regulation of the feed, according to the speed of the engine.

From the foregoing suggestions it is evident that the subject of steam cylinder lubrication offers a wide field for exact engineering investigation, which should be more generally undertaken and the resulting data made available to all those interested in the efficient operation of steam engines.

Plans are under way for a large electrical project in Esterbothnia, Finland, covering 3 towns and 28 rural districts. This includes 4 stations for generation of electrical power, and the absorbing of all small electrical undertakings now existing in the districts covered. The source of power will be waterfalls and extensive peat deposits. Further information can be had from the Bureau of Foreign and Domestic Commerce, Washington, D. C.

Contract has been let to C. F. Hamilton, of Franklin, Pa., for a boiler house and power plant for the State Institute for Feeble Minded at Polk, Pa.

Indicators---III

DETAILS OF MODERN TYPES; CARE OF INSTRUMENT

AS SHOWN in section, Fig. 17, Thompson's Twentieth Century indicator consists of the steam cylinder, straight-line motion and paper drum mounted upon a single support and provided with an inside or outside spring as desired.

The piston made of special metal with a sectional area of ½ sq. in., is well finished and provided with grooves for water packing. The piston rod is made of 3/16-in. steel, hollow at the upper end, threaded to receive a swivel (for adjustment of the pencil arm for vacuum) and turned smaller at the lower end to reduce its weight.

The bearings of the parallel motion employed are reinforced in order to get the advantage of length, and are accurately fitted, securing freedom of movement without lost motion. The pencil holder is made thin and split in both sides to allow the lead or metal point to be put in from either side, as the indicator is used either as a right or left-hand instrument.

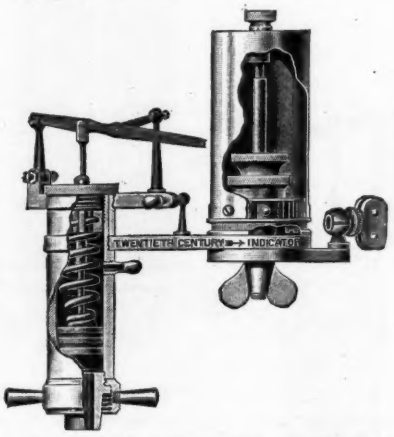


FIG. 17. THOMPSON'S TWENTIETH CENTURY INDICATOR

One and three-quarters and 2-in. paper drums are used, the former being provided, unless the 2-in. size is specified when ordering.

The drum spring is a flat coil of the clock pattern and can be adjusted for any practical speed by means of a knurled nut on the center post, after loosening the upper nut. The lower one, to which the spring is attached, can be turned to the left to increase the tension, or to the right to lessen it, setting up the lock nut to hold it in place.

The indicator can readily be changed from right hand to left hand by changing the paper drum from one notch to the other, and by turning the pencil arm around to the opposite side.

Springs employed in this indicator are of tempered and tested spring wire and are not ground down to a scale but are screwed in or out of the star end until the correct tension is obtained.

THE TRILL UNIVERSAL INDICATOR

THIS INDICATOR, shown in section in Fig. 18, derives its name from the fact that it can be used directly for precision indicating of steam, gas, or oil engines, air and ammonia compressors and pumps, regardless of pressure, length of piston travel or speed. It can readily be changed from a right-hand to a left-hand indicator for use on either right or left-hand machines.

Except in the case of those indicators employed entirely for ammonia work, and which are made of steel throughout, the body frame of the Trill Universal Indicator is made of brass with 3 heavy, equally spaced steel pillars or posts connecting the cylinder case with the indicator frame. Provision is made for the use of 2 separate and interchangeable hard bronze cylinders, one of which is fitted with a piston having a sectional area of ½ sq. in. and to be used under ordinary steam

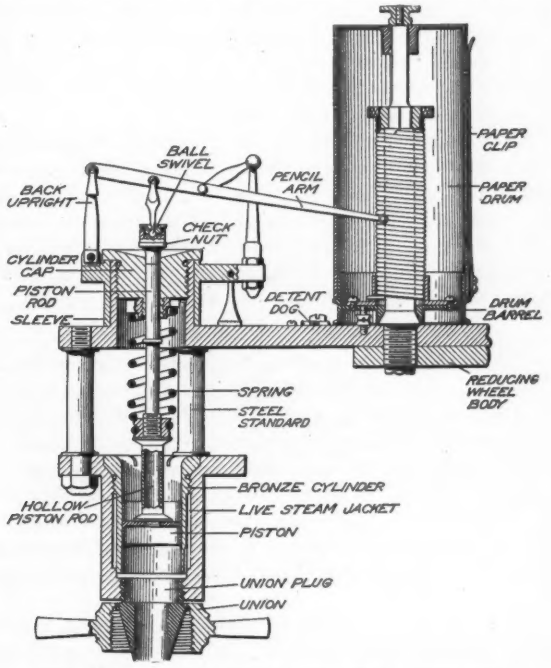


FIG. 18. SECTION, TRILL UNIVERSAL INDICATOR

pressures, while the other, the high-pressure piston for indicating high-pressure steam, gas and oil fuel engines is ¼ sq. in. in area. For ammonia work an additional cylinder and piston of steel can be furnished, thereby eliminating the necessity of an extra steel indicator. The cylinder case is of slightly larger diameter at its center to form a recess between the cylinder and cylinder case which serves as a live-steam jacket to minimize condensation in the indicator cylinder. The top of the cylinder is open to the atmosphere, making back pressure impossible.

The piston rod is of tool steel with the lower end threaded into the piston head, and the upper end, which is hollow to make it as light as possible, tapped to receive the thread of the small ball swivel socket directly connected to the pencil arm. The cylinder sleeve carrying the pencil motion is so fitted that it turns freely and is held in place by the flange on the cylinder cap. This cap is threaded into the cylinder and brought to a solid and true fit against a shoulder. The outside rim is slightly larger in diameter than the cylinder and

knurled for the purpose of easy removal when it is desired to change the spring, oil the piston or change the cylinder.

For conveniently swinging the pencil point against the card, the cylinder sleeve is provided with a small bone handle, and an adjustable stop, locked in any position by means of a check nut, makes it impossible to force the pencil too hard against the paper drum.

The pencil movement is of the Thompson type, and every joint and bearing is designed and reamed to eliminate lost motion. The back links are made in one solid piece with adjustable hardened cone bearings at the lower end and a fork at the top large enough to receive the 3/8-in. wide pin bearing on the end of the pencil rod.

The paper drum, made of seamless brass tubing with closed reinforced top and mounted on a steel shaft is 1¾ in. in diameter, although a 2-in. drum is furnished if desired. The drum engages its base by a sliding fit, the lower end being recessed to fit over a steel block in the base to prevent the drum from slipping and held in place by a knurled nut at the top.

Two standard springs of the required stiffness ordinarily supplied with each indicator are made from steel wire wound at red heat with 4 turns per inch. The moving head, or lower end, is a threaded bushing screwed into the spring; the upper end is soldered into a block having 4 wings and a threaded central hole, which engages the stem on the under side of the cylinder cap.

Improved Robertson-Thompson Indicator

In this indicator, built in 2 styles, one for steam and gas engine and the other for ammonia compressor service, the cylinder sleeve and paper drum are joined by a rigid bracket. The steam jacketed cylinder, by means of which losses due to condensation are eliminated, is screwed into the cylinder sleeve from the bottom and by means of the connecting duct, any steam finding its way to the top of the piston is conducted to the atmosphere through a swivel elbow, thus removing any possible back pressure.

The pistons employed, of which there are 2, one ½ sq. in. and the other ¼ sq. in. in sectional area for gas engines and high-pressure service, are made of special metal and provided with the usual water or packing grooves and are fitted with a steel stem into the end of which is screwed a ball-jointed top link which allows the pencil arm to be raised or lowered to any desired height.

Parallel motion is of the Thompson type with steel pencil lever, links and screws. The movement of the piston is multiplied 5 times at the pencil point, and in order to insure convenience in the testing of condensing engines a 3¼-in. pencil movement has been provided.

Piston springs of steel wire made with a pitch of 4½ turns per inch are used. The upper heads are formed of special metal having 4 wings with holes drilled to receive the coils, final adjustment being made by screwing the coils in or out of this head, after which they are firmly secured.

The card drums are made of seamless brass tubing with closed reinforced tops and either 1¾ or 2 in. in diameter. The drum stand is so arranged that the drum has a bearing not only at the base but, as shown in Fig. 19, also at the center where the spiral-leaf coil spring is enclosed in the case.

Ratchet teeth are cut on the bottom flange of the drum carrier and a handle is provided to engage or disengage the pawl, enabling the operator to stop the drum to remove and replace cards without disconnecting the cord from the engine crosshead.

This indicator is adaptable to any style of engine and may be changed from right to left hand and vice versa in but a moment's time.

Care of the Indicator

As a rule, the cylinders of modern steam engines are already tapped for indicator connections when erected. Occasionally, however, the engineer must drill and tap these holes himself, and when doing so should take care to have the holes far enough into the clearance space so that they will not be partially covered at the end of the stroke and thereby render the diagram worthless. One-half inch pipes and fittings with standard threads should be used.

Directions for connecting up the piping and 3-way cock on the engine cylinder are given in The Indicator Book published by the Trill Indicator Co. as follows:

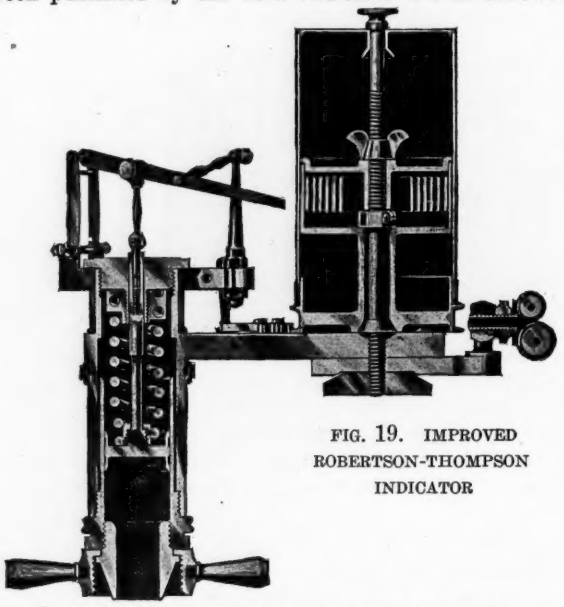


FIG. 19. IMPROVED ROBERTSON-THOMPSON INDICATOR

After having placed nipples and elbows in position on the cylinder ends, cut a piece of pipe about 1 in. shorter than half the length between the 2 elbows and thread each end. Screw the pipe into one elbow; then place the 3-way cock at the other end of the pipe. Next remove the large nut at the end of the 3-way cock and insert a piece of pipe, marking it so it will just clear the face of the elbow; then cut it off and thread one end. Slip the large nut onto the pipe and screw the pipe into the elbow, packing the joint where the pipe enters the 3-way cock, with candle wicking or other good packing and draw the nut up tight. Before putting the indicator in place, however, blow out the pipes thoroughly to prevent any dirt or grit from working into the indicator cylinder. When the indicator is not in use, the caps provided for the purpose should always be placed on the cocks to keep out the dirt.

Proper indicator performance to a great extent depends upon the free movement of its mechanism, which may be assured by the frequent and generous use of a

high-grade machine oil, paying special attention to the cylinder, joints of pencil movement and drum spindle. If a reducing wheel is used, this also will require to be well oiled.

Tension on the drum spring should be increased for high speeds and decreased for low speeds, so as to allow the drum to revolve without slack in the cord on the return stroke.

After using the indicator, wipe off all parts carefully with a soft cloth and together with springs and tools place it in its case.

Proportioning of Surface Condensers

OUTLINE OF METHOD FOR DESIGNING CONDENSERS

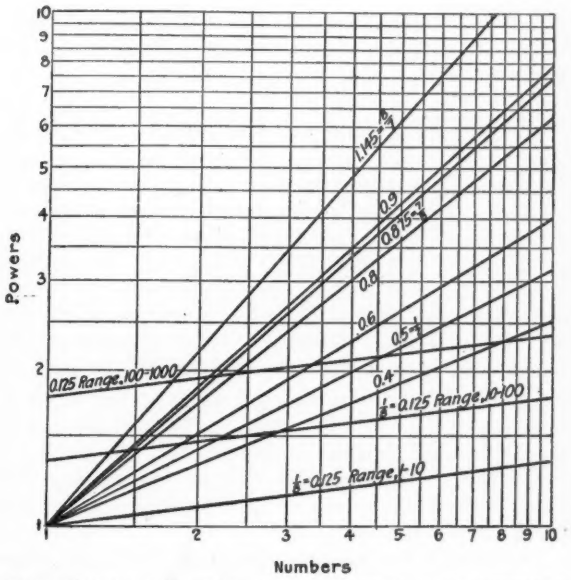
At the annual meeting of the American Society of Engineers, George A. Orrok gave a review of several recognized good methods of condenser design, the method used and recommended by him being as follows:

Condenser specifications usually call for the condensation of a certain amount of steam per hour, W (lb.), and the maintenance of a vacuum referred to standard barometer or absolute pressure, P_v, with condensing water at a certain temperature, t_0. The quantity of condensing water, Q, the hot-well temperature, t_s, the power used by the auxiliaries and the steam consumption of the auxiliaries may be also specified, but the problem is reasonably determinate when W, P_v, and t_0 are known. It is important that the place of measurement of the vacuum P_v be specified, as there is a well-defined drop through most condensers, the vacuum being greatest at the air-pump suction, less in the condenser, and least at the prime-mover nozzle. This drop may amount in well-designed condensers to 0.2 in. of mercury. The specified vacuum should be measured at the prime-mover nozzle, and the designer will then allow 0.1 to 0.2 in. for the drop in the condenser.

The absolute pressure in the condenser will then be 29.92 — (vacuum + 0.2 in.) = P_v. The steam tables may now be consulted and t_s the temperature corresponding to the vacuum, H = the total heat and q = the heat of the liquid to be taken therefrom. The final temperature of the condensing water approaches t_s, and for close work may be $t_1 = t_s - 5$ deg. In ordinary practice $t_1 = t_s - 7$ deg., or in some cases 8 or 10 deg. The ratio of condensing water to steam condensed, which is $R = \dfrac{H - q}{t_1 - t_0}$, may next be found. Many designers consider it close enough to use 1000 for $H - q$, on account of the moisture in the exhaust steam, and some few use 968. It is preferable to use $H - q$ not on account of its accuracy but as a slight factor of safety. Q, the quantity of condensing water = WR in lb. per hour.

At this point the size and thickness of the condenser tubes as well as the water velocity must be chosen. Most of the large installations in Eastern United States use 1-in. tubes on account of bad water conditions, although it has been stated that smaller tubes are more efficient. There are no definite experiments to decide this point. It is doubtful if anything is saved by the use of anything smaller than ¾-in. when the pumping head is considered. 1¼-in. tubes have also been used, but the consensus of opinion seems to be that a 1-in. tube can be cleaned better, keeps in good condition longer, and can be made better than either smaller or larger tubes. Let us take 1-in. tubes, No. 18 B.W.G., as standard. The formulas may readily be altered for other sizes of tubes when the constants are known.

With 1-in. tubes velocities from 7 to 10 ft. per sec. are now usual. We may take 8 ft. per sec. as the standard value for V_w.



LOGARITHMIC CHART FOR DETERMINATION OF FRACTIONAL AND DECIMAL POWERS OF NUMBERS

The number of 1-in. tubes in one pass will be given by the formula

$$n = \frac{Q}{990\,V_w}.$$

The length of water travel (l), or the total tube length, may be found from

$$l = \frac{30.8Q}{325\,V_w^{0.6}n}\left[(t_s - t_0)^{0.125} - (t_s - t_1)^{0.125}\right]$$

and the total tube surface S from

$$S = 0.262\,nl.$$

With 1-in. tubes from 40 to 80 will occupy 1 sq. ft. of tube-plate area, depending on the spacing and general design. The average will be about 60, making the cross-sectional area of the condenser (sq. ft.) equal to ($n \times$ number of passes) $\div$ 60. If there are 2 passes the length of the condenser will be $L = l \div 2 +$ depth of water boxes.

The illustration is a logarithmic chart for the ready determination of such fractional and decimal powers of numbers as are called for by the formulas given. For example, the 0.6 power of 4.5 is 2.5, found by following the ordinate erected at 4.5 on the horizontal scale to its intersection with the line marked 0.6, and then projecting horizontally to the vertical scale.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Operation of Traction Elevators

CONDITIONS WHICH AFFECT ECONOMY; AVERAGE RESULTS IN AN ACTUAL INSTALLATION. BY THOS. H. WATSON

WHILE no attempt is made in this article to list all the troubles that happen to traction type elevators, a few of the causes that affect the figures given below will not be out of place.

The daily handling of a large number of people is an item of considerable importance with the office building manager. To carry this number of people safely, quickly and economically is a subject that requires study. The cars must be run regularly and without bunching to prevent delay, and any defect noticed in the operation should immediately be reported and repaired. In the order of their importance the 4 factors most directly affecting the economical operation of the cars are given. A badly working gate will cause more trouble and delay than anything connected with the car. The usual trouble is that the gates stick, and the hardest thing to locate and remove is chewing gum caught beneath the gate.

The next trouble is due to faulty action of the brakes, a brake that stops the car too suddenly is not only hard on the car and operator, but a source of annoyance to the passengers. A brake set so loose that the car slides past the floor means a waste of power as each starting of the car, as will be shown, takes an excess of current sufficient to run the car a certain number of feet, to say nothing of the delay it causes.

A careless operator can cause a high wattmeter reading per car-mile by not stopping the car even with the floor, necessitating reversing, or by not paying attention to the passengers as they call their floors. The car should always be stopped even with the floor to prevent the chance of accidents from people stumbling when entering or leaving the car.

An indifferent public can do much to increase the cost of elevator service in many ways. A few of the causes are, signaling the elevator to stop and then returning to their office for something they have forgotten, by calling the wrong floor or waiting until they have reached their floor before signifying their intention to leave thereby causing the operator to reverse the car to meet the floor level. Some people have a habit of entering the car and then requesting the operator to let them out as they must return to their office, while others stand in the door while completing a conversation with a fellow passenger. If an operator says anything to this class of passengers he is usually reported to the office for insolence and there instructed to be more careful in the future.

The figures here given are an average covering a period of 4 yr. on a bank of 8 elevators traveling 16 stories. A difference in watt-meter readings between the switchboard and pent house is noticed and is due to the field switches being left closed on the motors at night while the cars are not in service, and results in a higher reading from the switchboard meters. This practice has been abandoned and the readings are becoming more nearly alike each month.

TRAVEL

Trips per day, about	175
Trips per mile	28
Miles per trip	0.0357
Miles per month per car, average	429.5
Total miles per month, 8 cars	3,436.13
Stops per trip, up	6.5
Stops per trip, down	6
Average stops, round trip	6.25
Stops per mile	175

CURRENT

Watts per car-mile	4633
Watts per car-mile, pent-house	4633
Watts per car-mile, switchboard	4705
Difference in readings in watts per mile	72
Starting current in amperes from	180 to 210
Running current in amperes from	70 to 90
Cost of current per kw. hr.	1c

LABOR

Electrician per month	$100.00
Electrician per mile	2.9c
Operators per month, average	$65.00
Operator per mile	15.1c
Total cost of labor per mile	18c

RENEWALS

Cost of parts per month	$5.00
Cost of parts per mile	0.145c
Cost of new cables	$150.00
Cost of cables per mile	0.84c
Life of cables in miles	17,822
Length of cables=6×230 ft.	1,380 ft.

RUNNING TIME

Time going up	45 sec.
Time going down	69.5 sec.
Time for complete trip	2 min. 38 sec.
Rest time at top	26 sec.
Rest time at bottom	19 sec.

Cost per Mile	
Current per mile	4.633c
Electrician per mile	2.9
Operator per mile	15.1
Cables per mile	0.84
Renewals per mile	0.145
Total cost per mile	23.618c
Cost per passenger per mile	1.687c
Average cost per passenger per trip	0.060,25c
Cost of car per trip, average load	0.8435c
Cost per stop	0.043c

Passengers	
Daily total average	20,000
Daily average per car	2,500
Per trip	14
Per mile, computed	392
Excess of starting current over running current in amperes	115 amp.
Distance car should travel on excess starting current	49 ft.

A car leaves the top and bottom of shaft every 23 sec.

As it hardly ever happens that all the elevators start at the same hour in the morning, the man in charge is given an opportunity to adjust and inspect the contacts on a board each morning, and to make an inspection of the car. Trouble with the signal system, other than that arising in the cables, can usually be repaired while the cars are in operation without interference with the service.

Graphic Representation of Alternating Current

Use of Polar Co-ordinates Simplifies Understanding of Phenomena. By G. P. Roux

A READILY understood representation of alternating-current phenomena is given in the form of polar co-ordinates, which combines a clear exhibition of angular position or time, direction or polarity of current, as well as value or amplitude, so that the entire performance is apparent at a glance. In polar co-ordinates the radius vector for any time position gives the instantaneous value of the phenomena. In Figs. 1, 2 and 3 are represented single, 2 and 3-phase currents which, being assumed to be of a sine wave and balanced, are indicated by circles whose diameters correspond to the relative instantaneous maximum value of each corresponding current.

A single-phase current is shown in Fig. 1, the line *OT* representing the time rotating counterclockwise around the center of rotation of the system *O*, and passing by all the current values of the phase indicated by a circle for a sine wave. The maximum value is reached when the time in its complete revolution for a cycle attains the angular positions 90 deg. and 270 deg.; therefore, in time position *OT* the current is at maximum positive value, or 113.6 times the square root of 2 times sin. 90 deg., or 160.6; as this time line further rotates, the current gradually decreases in value until it reaches zero at time position *OT'*, then again rises gradually in a reverse direction of flow, or with a negative sign during the second half of the cycle.

A 2-phase system is shown in Fig. 2, the phases being in 90 deg. relation. Here when the current is maximum in phase *A*, as represented by the time position *OT*, it is at minimum or zero in phase *B*. The minimum instantaneous value of the currents in both phases *A* and *B* is reached at time position *OT'*, when the current in each phase is (56.8 times the square root of 2) times sin. 45 deg., or 56.8 amp. The current in each phase has half the value of the single-phase current in Fig. 1 for each corresponding time position in phases *A* and *B* and, as the circuit consists of 2 looped wires independent of each other, the total weight of the conductors is the same as for the single-phase circuit, that is, they have half the cross-section but twice the length. Inasmuch as when the current in one phase is at maximum it is at zero in the other, it is possible when the phases are not electrically interconnected to use a common return for the 2 phases. This reduces the number of wires from 4 to 3, thus effecting a saving of 25 per cent in the conductors. The current in the common

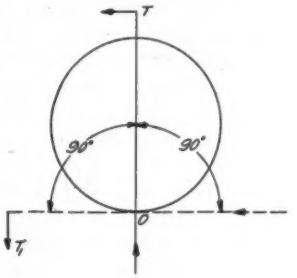


FIG. 1

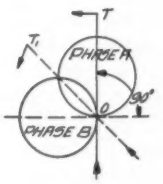


FIG. 2

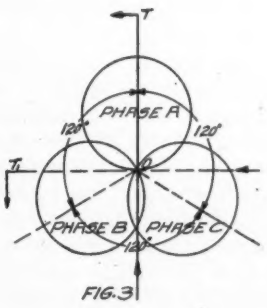


FIG. 3

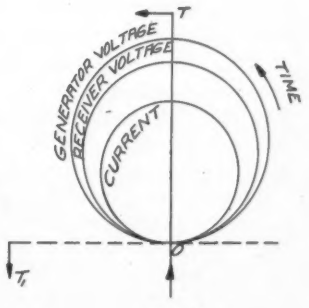


FIG. 4

FIG. 1. GRAPHIC REPRESENTATION OF SIGLE-PHASE CURRENT
FIG. 2. GRAPHIC REPRESENTATION OF 2-PHASE CURRENTS
FIG. 3. GRAPHIC REPRESENTATION OF 3-PHASE CURRENTS
FIG. 4. RELATION BETWEEN RECEIVER VOLTAGE, GENERATOR VOLTAGE AND CURRENT

return is equal to the vector sum of the 2 currents at 90 deg., and is the same as the maximum value in either phase, in this case 80.3 amp.

The advantage resulting from the saving in conductors in a 2-phase, 3-wire system is largely offset by

operating inconvenience. Even with balanced load in each phase the current in the middle wire is 41 per cent greater than in the outside wires. This system carries unbalanced currents and, the line drop being greater in the common return wire than in the outside ones, the phase angle symmetry of the voltage at the receiver end is affected to the detriment of the regulation of the circuit. These conditions are greatly aggravated if the system has its phases unbalanced or each phase with a different power-factor. Furthermore, the voltage across the 2 outside wires is equal to their vector sum, or 41 per cent greater than the phase voltage, and requires additional insulation, or else they are subjected to greater stresses. Besides, special care must be taken in making connections to apparatus on account of this difference of voltage between wires.

The inconvenience resulting from a greater current density in the middle wire could be overcome by increasing its cross-section 41 per cent, in which case the saving in conductors would be reduced to 341 divided by 4, or 85 per cent that of a 2-phase, 4-wire system, the saving being only 15 instead of 25 per cent.

A 3-phase system is represented in the same manner in Fig. 3, each phase being 120 deg. from the others. In time position *OT* the current is at maximum in phase *A*, or 65.6 times the square root of 2, or 92.8 amp., and in phases *B* and *C* is 92.8 times sin. 30, or 46.4 amp., or half the value of that of phase *A* and flowing in the opposite direction. In this system, as in the 2 others, the time rotates around point *O*, the center of rotation of the system. The minimum instantaneous value of any of the phases is attained when in time position *OT'*, where the current in phase *A* is zero, and 92.8 times sin. 60 deg. equals 80.4 amp. in phases *B* and *C*, respectively, but in opposite directions. It is to be noted that at all instants in the 3-phase system the total sum of all currents is always zero; also that potential drop follows the cycloidal function of the period, as well as the current and voltage in each branch, starting from zero, then increasing to maximum and positive, and then decreasing, passing by zero and following in the reversed order or negative to complete the cycle.

The relation of the receiving end voltage to the generator voltage is shown with polar co-ordinates in Fig. 4, for a single-phase current where both current and voltage are in phase. When, however, the current is lagging or leading the voltage, the potential drop does not follow the cycloidal amplitude of either, but causes a further phase displacement of the receiving end voltage. Where the wave is distorted and not a sine wave, the displacement reaches greater proportions and its graphical representation requires the plotting of ordinates. In 3-wire, 2-phase and 3-phase circuits, an unbalancing of the phases also affects the shape and value of the voltage waves at the receiving end.—The Electric Journal.

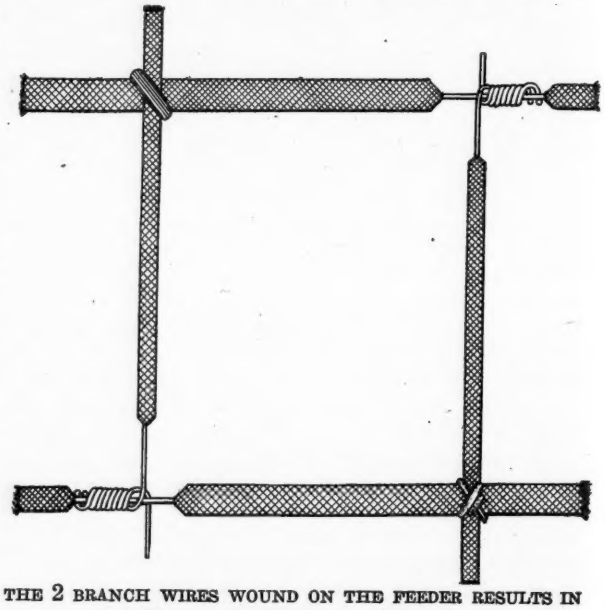
In March, 1917, a sample or wholesale fair will be held at Lyons, France, where manufacturers will have an opportunity to get in touch with the wholesale buyers of that country. Special arrangements are being made to induce American manufacturers to exhibit, about which full information can be obtained from Geo. B. Van Cleve, Chairman, 1790 Broadway, New York City.

A Neat Branch Connection

By T. H. Reardon

IN SHOP and mill lighting circuits there are numerous calls for double-tee branches to furnish service to end and side drop lights. When such a branch is to carry more than 660 w. a porcelain crossover cutout is required; but, when such a branch is to carry less than 600 w. the cutout can be dispensed with and a neat crossover made in the following way. Bare the ends of the branch wires the proper distance for a wrap splice and if the wire is sufficiently pliable, wind 2 of these side by side in parallel, around the feed wire.

If this cannot conveniently be done wind one wire in a sort of a loose spiral leaving enough room to accommodate the second one between the convolutions and



THE 2 BRANCH WIRES WOUND ON THE FEEDER RESULTS IN A NEAT AND SYMMETRICAL CONNECTION

then fill in with the second wire. Now draw the 2 branch wires in opposite directions from the feed wire and they will come to a straight line making a right-angle crossing. The advantages of this method may be summed up thus: The branch leads are in the same straight line and therefore symmetrical, whereas if one wire was wrapped around the feed in splicing and the other wire wound on top of it the winding would be bunched or, if the second wire was wound on the feed wire beyond the point where the first winding ended it would be carried out of line. With the parallel winding of the splice the distribution of solder is much more uniform and the appearance of the taped joint is also much neater.

It will be noticed also that the splice wrapping appears outside of the rectangle of wires, a matter that will be found convenient when the blow torch is applied when soldering. The wires connected as shown are to be protected with suitable clay tubes where they cross over each other and movement of the tubes prevented by cleats at their ends.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Internal Combustion Engines as Applied to Tractors

RESULTS OF INVESTIGATION CONDUCTED TO DETERMINE PERFORMANCES OF VARIOUS TYPES OF MOTORS

IN a paper presented by A. A. Potter and W. A. Buck at the 1916 Annual Meeting of the A. S. M. E., considerable information was brought to light in the form of results of an investigation instituted to determine the fuel economy and thermal efficiency of different types of internal-combustion motors employed in traction engines, to determine the practicability of the use of fuels heavier than gasoline, and to compare the rating, valve timing and other details of commercial engines.

METHOD OF TESTING

THE VARIOUS ENGINES were tested by a 4-wrap rope brake (circumference, 10.528 ft.), the speed of the brake being determined by an automatic counter. Platform scales reading to ½ lb. were used for the brake, and scales reading to ½ oz. for weighing the fuel, water and lubricating oil. Fuel samples were taken during each test, the heat of combustion of each sample being determined by a Junkers calorimeter and the specific gravity by a hydrometer. Revolutions of engine and of brake were taken every 6 min. and the weights of fuel, injection water, and lubricating oil every 30 to 60 min. Four-fifths of the tests were 60 min. duration; the others of 22 to 30 min.

TABLE I. FUEL ECONOMY FOR VARIOUS GROUPS OF MOTORS TESTED

Per Cent of Full Load	Fuel Consumption, Lb. per B.H.P per Hour				
	Group I		Group II	Group III	
	Gasoline	Kerosene	Gasoline	Gasoline	Kerosene
25	1 853	1 990	1 416	1 47	1 827
50	1 147	1 265	0 893	0 93	1 190
75	0 940	1 044	0 767	0 78	1 013
100	0 855	0 935	0 720	0 73	0 977

GENERAL CONCLUSIONS

FROM THE RESULTS of this investigation the authors derived the following general conclusions:

a The 4-cylinder motor is better adapted for belt work on account of the greater number of impulses per revolution.

b The single-cylinder and the 2-cylinder motor operate better than the 4-cylinder motor with fuels heavier than gasoline.

c Carburetors now used are satisfactory for gasoline, but a carburetor jacketed with heat from exhaust gases should be employed when operating with kerosene or with the heavier fuels.

d The ordinary automobile motor is too light for traction-engine work. The traction-engine motor should operate at lower piston speeds than the automobile motor. Motors operating at piston speeds of 700 to 900 ft. per min. are giving satisfaction.

e The vertical types of motors are preferable on account of longer life and greater accessibility.

f The valve-in-the-head type of motor has the more efficient combustion space and is to be preferred to the T-head or L-head types.

TABLE II. COST OF TRACTION ENGINE POWER WITH GASOLINE AND KEROSENE AS MOTOR FUELS

Per Cent Load	Cost per Horsepower-Hour in Cents with								
	60° Baumé Gasoline at Prices per Gallon (in Cents) of					45° Baumé Kerosene at Prices per Gallon (in Cents) of			
	9	12	15	18	21	5	7	9	11
Group I[1]									
25	2 72	3 62	4.53	5 43	6 34	1 49	2 10	2 70	3 30
50	1 68	2 24	2.80	3.36	3 93	0 95	1 33	1 71	2.09
75	1 38	1 83	2.30	2 75	3 22	0 78	1.10	1 41	1 71
100	1 25	1 67	2 09	2 51	2 93	0 70	0 98	1 26	1 54
Group III[2]									
25	2 16	2 88	3 59	4 31	5 03	1 37	1 92	2 47	3 02
50	1 37	1.82	2.27	2·78	3 18	0.89	1 25	1.61	1 97
75	1.14	1 53	1 90	2 29	2 67	0 76	1 06	1 37	1 67
100	1.07	1 43	1 78	2 14	2 50	0 73	1 03	1 32	1.61

[1] Motors developing 15 to 26 b.h.p. on full load. [2] Motors developing over 51 b.h.p. on full load.

g The combination of the forced feed and splash oiling system gives good results.

h The jump-spark system, on account of its mechanical simplicity, is the best system of ignition for traction engines of more than one cylinder.

i The fuel-economy range is from about 1.30 lb. b.hp. per hr. at ¼ load to about 0.7 lb. per hr. at full load. The fuel consumption in lb. per b.hp. per hour is nearly the same for both gasoline and kerosene.

j The thermal efficiencies at full load vary from 14.88 to 19.8 per cent for gasoline fuel, and from 13.7 to 15.97 per cent for kerosene.

In order to facilitate comparison of various types, the motors tested were arranged in Groups I, II and III, the first including those developing at full load 15 to

26 hp. on brake, the second those developing 26 to 51 b. hp., while the third group included those of more than 51 b. hp. The average fuel economy for these various groups is as shown in Table I, with a comparison of operating costs with kerosene and gasoline as fuels tabulated in Table II. Computations could not be made for Group II, as the engines in this class were not operated on kerosene.

Table II illustrates the advantages of the kerosene-burning engine. Considering Group I, 10.07 gal. of kerosene will deliver as much power as 10 gal. of gasoline. With kerosene at 10 cents per gallon and gasoline at 20 cents per gallon, the cost with the latter fuel will be 1.99 times that with kerosene for the same power developed. Considering Group III, 12.32 gal. of kerosene will deliver as much power as 10 gal. of gasoline, thus giving a ratio of 1.62 to 1 with 10-cent kerosene and 20-cent gasoline. The advantages of the kerosene engine are offset to a greater or less degree, depending upon the operator by the added trouble in handling. The life of the motor will also be somewhat shortened when using kerosene fuel. To this should be added the lower reliability with the heavier fuel.

TABLE III. VALVE TIMING FOR MOTORS OF TRACTION ENGINES

Speed of Motor, r.p.m.	Exhaust Valve		Inlet Valve	
	Opens before outer center	Closes after inner center	Opens after inner center	Closes after outer center
200	20° to 25°	0° to 3°	0° to 3°	15° to 20°
300	22° to 27°	0° to 5°	2° to 5°	15° to 20°
400	27° to 32°	2° to 5°	2° to 7°	15° to 20°
500	30° to 35°	4° to 8°	5° to 10°	18° to 23°
600	35° to 40°	4° to 8°	8° to 12°	18° to 23°
700	40° to 45°	6° to 10°	10° to 12°	20° to 25°
800	45° to 50°	6° to 10°	10° to 12°	20° to 25°

Due to the high price of gasoline new carburetors are being placed on the market which handle kerosene very satisfactorily, and eventually it will be used more as a fuel for traction engines than will gasoline.

A study of the valve timing of the different motors tested shows no uniformity, except that the majority of the motors are so timed that the inlet valve does not open until after the exhaust valve is closed. The timing given in Table III is offered as a result of the authors' study and experience with traction engines.

An Interesting Experience

By Chas. Labbe

ANE of our 60-hp. gas engines developed a knock at its wristpin which we attempted to eliminate by tightening the wedge used to adjust the brasses of the connecting rod at that point. After the play had been fairly well taken up, we ran the engine at no load. We then put on full load for about 5 min., when suddenly a peculiar sound was heard inside of the cylinder, growing worse until it seemed the engine was going to pieces. This then really did occur. The bolts holding the connecting rod brasses in place snapped off, the piston came out of the cylinder and was thrown about 2 ft. into the air and after making one more revolution in this fashion, broke from the connecting rod and finally landed on the floor 3 ft. from the engine.

No one was harmed and the damage done was insignificant, consisting of 5 broken piston rings and 2 broken connecting-rod bolts.

After a thorough inspection, we discovered the original trouble not due to the looseness of the wristpin as we had at first thought, but found the piston rings had become stuck hard in place caused by carbon deposits and resulting in the piston working abnormally hard. This tended to bind the piston in the partly dry cylinder or possibly a ring broke and may have wedged the piston tight.

SHOWING POSITION OF PISTON AFTER BEING THROWN FROM ENGINE

With only the breaking of 5 piston rings and 2 connecting rod bolts, I consider the accident a "lucky" one in view of what might have happened.

News from Washington

By A. P. Connor

DURING the past few months the various engineering departments of the Government in Washington, have been busy, the army designing and letting out contracts for aeroplanes, automobiles, ordnance, and other mechanical equipment constructed in engineering establishments; the Reclamation Service developing the large dams under its jurisdiction in various parts of the country, and the incidental power plants that are in many cases connected therewith; the Alaskan Railway making great progress; the Panama Canal putting on the extras required in its operation; the United States Engineers (partly army and partly civil) making further progress on the deepening and damming of the large rivers, thereby greatly preventing or reducing the disastrous floods that would otherwise occur, and at the same time conserving and improving the water transportation of the large rivers; the Navy Department rushing work on new ships, submarines, guns, and other parts of this department; the Commerce Commission improving features in railroad construction and operation.

Treasury Power Plant

The treasury power plant, recently referred to in Practical Engineer, which is being erected in the parking system of Washington, and out of alinement with the

buildings that it is proposed to supply with power and heat, has met with further difficulties. For several months the Department has been cognizant of the unsafe foundation conditions that have existed at the site of the proposed power plant and have tried to cover the belated discovery, and lack of proper investigation, by forcing the contractor for the building to do a considerable extra amount of piling work at his own expense. The contractor objected and would not stand for the blame, and after several months of delay and discussion, the Treasury Department is to make new plans, and now puts the blame for the conditions on the consulting engineers who were incidentally called in, when the plans were practically completed, and whose advice and suggestions were overridden and ignored. The cost of the plant to the Government, it is anticipated, will be excessive, its operation will be inefficient, and its position in the parking system of Washington has been objected to by the leading engineering and architectural societies of the country, and by the Arts Commission established by Congress. This Commission was mainly established to prevent such monstrosities of building construction, but in the case of this power plant of the Treasury Department no cooperation has been extended by the Department to the Commission, but an arbitrary placing of the power plant has been made, in spite of all protests, and apparently for no other reason than to give the Supervising Architect more jurisdiction.

The Armor Plant

There are prospects that the new $11,000,000 armor plant will be erected in Washington and adjacent to the Washington Navy Yard. Should this be done, it will necessarily result in the development of water-power in the city of Washington by damming the Potomac river and impounding a large lake which will be the water supply of the city, the excess being used for power purposes. Increased water supply is urgently needed, as the present system will become inadequate in about 5 yr., and provision must be made at an early date, but building of the armor plant would result in immediate action. Rivers about Washington are being deepened for large vessels, great river walls being constructed, big areas of land are being reclaimed and made into parks, and a number of beautiful government buildings are in progress of construction.

Power Bills

Prospects of the Water Power Bills being passed at this session are good, as they are in better shape than before, because of investigations and reports in the matter have given the bills such shape that they are more satisfactory to all the conflicting interests that are involved. It is believed that something will be done in the matter, and thus enable the great water power projects of the country to be constructed and the people of the country benefited thereby, as well as furthering the interests of the engineering professions.

A hardware concern in Central America, whose address may be obtained by referring to No. 23,139 and writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., is in the market for boiler tube cleaners for tubes from ½ to 5 in. diameter.

Heat Va ue o Coa

Method of Calculating Heat Value of Coal from Proximate Analysis. By W. F. Schaphorst

An interesting card distributed by Peale, Peacock & Kerr, of New York, was sent to me a short time ago. It is entitled, "To Calculate British Thermal Units."

The calculation is based on the proximate analysis of the coal, and since almost anybody can make a proximate analysis with crude apparatus I obtained permission from the above firm to develop and publish a chart based upon their useful card.

In order to use this chart, which is published in the Practical Reference Tables of this issue, it is necessary to know 3 percentages: (1) fixed carbon, (2) ash, and (3) moisture.

Run a straight line from the fixed carbon (column A) to the sum of moisture and ash (Column B) and locate the Key in column D. Locate this Key number in column E, called Transfer, and connect it with the sum of moisture and ash (which has already been located in column B) and the intersection with column C gives the heat value of the coal.

Key	No.	Key	No.	Key	No.	Key	No.	Key	No.
50	12240	60	14580	70	15590	80	15840	90	15480
51	12600	61	14760	71	15630	81	15840	91	15390
52	12840	62	14940	72	15660	82	15830	92	15300
53	13100	63	15120	73	15690	83	15810	93	15210
54	13320	64	15210	74	15720	84	15780	94	15120
55	13560	65	15290	75	15750	85	15750	95	15000
56	13800	66	15360	76	15780	86	15710	96	14880
57	14040	67	15420	77	15800	87	15660	97	14760
58	14220	68	15480	78	15820	88	15600	98	14670
59	14400	69	15540	79	15830	89	15540	99	14580

For example, let us take a sample of coal showing 54 per cent fixed carbon (column A), and the sum of moisture and ash amounting to 10 per cent (column B). The extended dotted line gives us 60 (column D) as the Key. Locating that number (60) on column E we run over to the 10 (column B), and the intersection with Column C shows the heat value of the coal to be very close to 13,100 B.t.u. The dotted lines indicate the 2 positions of the straightedge necessary for the determination of heat value.

It is stated on the card published by Peale, Peacock & Kerr that this method is accurate within 100 B.t.u.

In case it is desired to calculate the result mathematically without the aid of the chart, here are the rules as given by the above firm:

Rules

1. Deduct sum of moisture and ash from 100.
2. Divide result into percentage of fixed carbon.
3. Multiply this result by 100 and you have the key to the accompanying table.
4. Consult the table to find the corresponding number.
5. Multiply the number by the figure found by Rule 1.
6. Point off 2 decimal places. Resulting whole number is B. t. u.

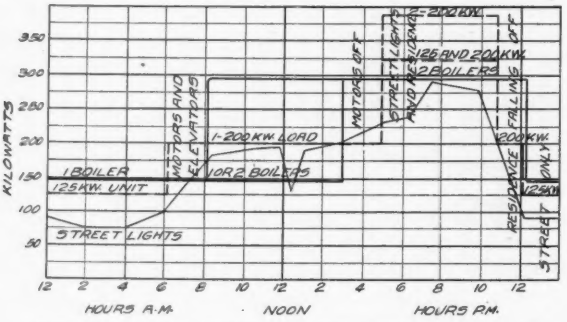
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Selecting Units for Power Plants

THE WRITER was recently asked the following question concerning the proper size and number of units to install in a power plant. This is a question that would admit of discussion among engineers and, in view of starting discussion on the subject, an answer is given here, together with my views.

"An electric light and power plant in a small town has a minimum load of 75 kw. and a maximum load of 275 kw. at the switchboard, consisting of a few small shop motors, store elevators and service, street and residence lighting. What would be the proper size and number of boilers, engines and generators to install? State your reasons for this selection."



ESTIMATED LOAD CURVE AND PROPOSED PROGRAM OF OPERATION

For a minimum load of 75 kw. and a maximum load of 275 kw., I would determine the size and number of units in the following manner: The efficiency of the generators is assumed to be 90 per cent and that of the engines, 92 per cent. For a condensing plant in good condition, the steam consumption including the feed pump, etc., would be about 50 lb. per kw. with Corliss engines direct connected to the generators. One boiler horsepower equals the evaporation of about 32 lb. of water from the average feed water temperature. The minimum required generator capacity would be $75 \div .90 = 84$ kw., and the maximum is $275 \div .90 = 305$ kw. The engine horsepower required would be, minimum, $\frac{84 \times 1000}{746 \times 0.92} = 120$ hp., and the maximum, $\frac{305 \times 1000}{746 \times 0.92} =$ 444 hp. The minimum boiler capacity required would be $120 \times 50 \div 32 = 188$ hp., and the maximum, $444 \times 50 \div 32 = 694$ hp. The limits would then be:

Generator, minimum, 84 kw.; maximum, 305 kw.
Engines, minimum, 120 hp.; maximum, 444 hp.
Boilers, minimum, 188 hp.; maximum, 694 hp.

The individual characteristics would govern to some extent the size of the units to be required, and also the number of hours operated per day. If the service is to be 24 hr. a day and there is some chance of the load increasing, more capacity will be required than otherwise. The accompanying load chart is typical of what might be expected from a plant of this nature. From midnight until 6:00 a.m., the only load is the street lights with a very few residence lights, especially after 4:00 a.m. From 6:00 to 8:30 a.m., the few shop motors, store elevators, fans, etc., would form the load which would be fairly uniform throughout the day, except with a short drop at noon, until about 5:30, when the motor load would decrease and the show window and residence lighting would begin. This, with the street lights at 7:00 p.m., would constitute the peak load, lasting until 10:30 p.m., from which time it falls off rapidly until midnight to the street light load only.

Assuming 24-hr. operation, there should be installed 3 200-hp. boilers; 1 180-hp. engine direct connected to a 125-kw. generator; and 2 290-hp. engines direct connected to 2 200-kw. generators. The dotted and heavy curves show the boiler and engine capacity when referred to kilowatts as compared to the load on the plant. The best method of knowing just what the load factors would be, is to plot the capacities of the several units that would be required on the chart, from which it will be apparent which units should be in operation, and at what time the charges should be made. In the case at hand, from midnight until 6:00 a. m., the 125-kw. unit with one boiler would carry the load. At 6:00 a.m., 1 200-kw. unit would be started and the 125-kw. unit shut down. The 200-kw. unit would carry the ordinary day load except on a very dark day, on which either 2 200-kw. or 1 200-kw. and the 125-kw. units would be used in parallel with either 1 or 2 boilers, as required, until 4 p.m., when both boilers would be required to carry the peak load until about 11:30 p.m. With one engine in use during the day, 2 would be required to carry the peak load from 5:30 until 10:30 p.m., then 1 200-kw. until 11:30, changing over to the 125-kw. for the balance of the night. This method of operation would provide for as nearly full load as could be expected, and at the same time allow for some increase in business without seriously overloading the machines.

This arrangement of number of units would leave one boiler off for cleaning and emergency, and one spare engine in case of trouble, as any 2 units could carry the load. The units would operate at reasonably high efficiency and at a good load factor.

The boilers would evaporate $750 \times 32 = 24{,}000$ lb. of water per hour, or 2890 gal. if running at full capacity. Two feed pumps, or as a second choice one

pump and a good injector, should be installed. Each pump should be large enough to carry the full load and have a capacity of about 4000 gal. per hr., so that, in case the water became low, it could be quickly regained without trouble. At the usual pump speed, this would require a duplex pump 8 by 5 by 10, which is rated in pump catalogs at a little more than the required capacity, and would be large enough to carry an increase of load without overspeeding. J. C. HAWKINS.

Operating Condensing Engines

ON PAGE 893, Oct. 15, 1916, issue of Practical Engineer, D. W. asks for information on operating condensing engines. I cannot agree with the answer given to the question. I have read of several instances, and know of two in particular, where the engines were wrecked in shutting down by not first cutting out the condenser, before the engine throttle was closed. Both engines were cross-compound with independent jet type of condensers placed below the low-pressure cylinder, and in both cases a compound vertical air pump and jet condenser was used, although the accident happened in separate plants.

In one case the engine was a Corliss, and it had always been the custom in shutting down first to close the engine throttle, and then cut out the condenser. It happened at this time that just after the engine throttle was closed something went wrong with the condenser, which caused it to stop, and the vacuum breaker failed to work. Now, as no steam was passing through the engine cylinders to prevent a vacuum from being created there, and with the engine turning over, through the momentum of the flywheel, the low-pressure cylinder became a dry-air pump, and the exhaust valve being open gave direct communication between the low-pressure cylinder and the water in the condenser. The result was that the low-pressure side picked up a dose of water and the cylinder head left the engine, piston rod was bent and other damage done.

The other wreck happened in the plant where I am now employed, but prior to my engagement with this company. In this case, the engine was a Greene-Wheelock with the same type and make of condenser as in the former case, and the condenser is located below the engine room floor, being about 6 or 8 ft. below the engine cylinders. It has always been the custom here, and is at the present time, to close the exhaust valve first, or to have the oiler close the exhaust valve while the engineer closes the throttle, thus having the condenser cut out as soon as or a little before, the engine throttle is closed.

It appears that at the time this engine was wrecked the exhaust valve stem was broken when the valve was opened in starting up and when they came to shut down the valve could not be closed, so they took a chance and closed the engine throttle, the low-pressure cylinder pulled up a dose of water and the damage was done. I understand that in this case the condenser pump was shut down before the engine stopped turning over.

We have in our plant 6 cross-compound condensing engines, 2 500-hp. and 4 1000-hp., our condensers are all independent and are located below the engine room floor. In no case do we start up without first starting the engine before cutting in the condenser, and in no case do we shut down without first cutting out the condenser, or at least having the exhaust valve closed as soon as the engine throttle is closed.

Of course as long as the condenser pump keeps running there is practically no danger from water, but there is always the possibility of the pumps stopping at just the wrong time.

For the benefit of D. W., I will say that "cutting out" the condenser means closing the valve on the exhaust line between the engine and condenser and allowing the exhaust steam to pass to the atmosphere, while "cutting in" is just the reverse, or opening the valve and allowing the steam to pass to the condenser.

Just how you would proceed in starting up or shutting down a compound condensing engine, and feel that you were on the safe side, depends, to a certain extent, on whether you have a dependent or independent condenser pump.

The term dependent condenser applies to those that are dependent upon the engine for power to operate the pump, and usually consists of a single-acting bucket pump, connected, through arms and levers, to the crank, crosshead or some moving part of the engine.

The term independent condenser applies to all those which are operated by steam or electricity or any power independent of the engine.

With the independent type of condenser there is generally a valve on the exhaust line between the engine and condenser, which, when closed, compels the exhaust steam to pass to the atmosphere, and when open, allows the exhaust steam to pass to the condenser.

With the dependent type of condensers, especially the older types, there is no valve between the engine and condenser, consequently all the exhaust steam must pass through the condenser. One bad feature in connection with this type of condenser is that the pump cannot be started until the engine is started, and the exhaust steam would soon destroy the valves in the bucket if not protected by water; while, on the other hand, if water is turned on the condenser before the engine is started, there is a good chance of flooding the engine cylinder with water, especially if the water comes to the condenser under a head.

In starting up a condensing engine with the dependent type of condenser, the engine should be started first and the injection water gradually turned on as the engine is brought up to speed. In shutting down, before closing the engine throttle, first choke down on the injection water, allowing enough water to enter to protect the valves in the bucket from the heat of the exhaust steam. As soon as the engine throttle is closed, the vacuum should be broken by opening the vacuum breaker; or the indicator cocks on the engine cylinder will do just as well, as this will destroy the vacuum in the engine cylinder, and there will be less liability of water passing into the engine cylinder than would be the case if the vacuum was not broken.

As already stated, with the independent type of condenser, there is a valve on the exhaust line between the engine cylinder and condenser, which answers a double purpose. It allows the exhaust steam to pass from the engine to the condenser when open, and when closed

prevents water from passing from the condenser to the engine, provided the valve is in good condition and does not leak.

In starting up an engine with this type of condenser, the condenser should be started first. It is often necessary to prime the condenser pump, especially if the water does not come to the pump under a head, and all condenser pumps should have a priming line connected to the city main, or canal, or some source where the water will flow to the condenser. In starting up the condenser pump, if it does not pick up the water readily, stop the pump and open the priming valve for a few minutes, then start the pump again and as soon as it picks up the water close the priming valve. After getting the condenser operating properly, with the vacuum somewhere near the desired degree, open the throttle valve and start the engine. While the engine is slowly turning over, carefully open the exhaust valve and cut in the condenser. This valve should be opened slowly at the same time watching the vacuum gage, and it will be noticed that when the valve gets to the point of opening, the vacuum will generally take a sudden drop and the pump will start to race, especially if a steam driven pump. At this point, stop opening the exhaust valve for a short period and the vacuum will stop dropping and start back and the pump will generally stop racing; if it does not, choke down on the pump throttle a little.

As soon as the pump and vacuum are normal again, you may continue to open the exhaust valve more rapidly. When the exhaust valve is wide open, bring the engine up to speed and regulate the condenser pump for the desired degree of vacuum.

If the exhaust valve is opened too rapidly, when it gets at the point of opening the vacuum will drop back so far that you may lose it. In case this happens, immediately close the exhaust valve again, cutting out the condenser until you get the vacuum back again.

In shutting down an engine with independent condenser, the exhaust valve should be closed, cutting out the condenser, before the engine throttle is closed. It is also a good plan to let the condenser pump run until the engine stops turning over.

The reason for cutting out the condenser first in shutting down is this: When the engine throttle is closed there is a vacuum created, not only in the low-pressure cylinder, but in the receiver also, and if the condenser should happen to stop for any reason, the low-pressure cylinder immediately becomes a pump and there is a good chance of water being drawn into the cylinder. This was exactly what did happen in the 2 cases described above. This same reason applies to starting up a condensing engine before cutting in the condenser, and it also applies to simple condensing, as well as compound engines.

With a compound engine, as soon as the engine is started you should start the low-pressure side "cutting off," which is accomplished by changing the position of the knockoff cams through some means usually provided for this purpose, the nature and location of which depends upon the make of engine.

This cutting off will start raising a pressure in the receiver, and after the engine is up to speed and the load on, the cutoff can be changed to give the required receiver pressure. E. C. W.

Some Notes on Belting

I DISAGREE with Frank Richards' "Some Notes on Belting" in regard to 2 points only. In general, I read the article with much relish for I, also, am an advocate of lessened belt tensions. The "slack belt man" has all of the practical arguments on his side, whereas the "tight belt man" has to orate from the standpoint of theory and unsatisfactory practice.

Mr. Richards says, "The pulley surface, if microscopically examined, has minute elevations and depressions; the hard, smooth, unyielding hair side of the belt can only touch the high spots of the pulley surface and may not have actual contact with more than ½ of it."

This sounds as if the hair side of a belt, even though examined under a microscope, is perfectly smooth. It sounds as if the hair side of the belt is harder than the pulley itself. It is my belief that the hair side is also microscopically rough and the small elevations on that side will more neatly fit into the small depressions of the pulley face than will the larger projections on the flesh side of the belt

Secondly, I take issue with this statement, "The pulley should not be polished, but preferably as a scraping or wide faced, coarse feed turning tool will leave it."

A rough face on a pulley is bound to wear out the belt prematurely, especially if there are any cutting or grinding edges on the pulley face. It is true that a rough face will reduce belt slip down to zero, but it will not eliminate belt creep, and it is the latter that will therefore do the wearing. Creep often amounts to as much as 2 per cent. That is, the speed of the driven pulley will be 2 per cent less than the speed of the driving pulley. If, for example, the diameters of the driving and driven pulleys are equal, and if the speed of the driving pulley is 100 r.p.m., the speed of the driven pulley will be only 98 r.p.m. where the creep is 2 per cent.

Inasmuch as this creep is inevitable, isn't it logical that the creeping should be done over a smooth pulley surface?

I prefer to have a smooth pulley transmit as much power as it can by virtue of the high coefficient of friction given to it by proper treatment and by virtue of a large arc of contact as recommended by Mr. Richards himself. N. G. NEAR.

Gear Wheel Repair

A GEAR WHEEL got 26 teeth broken out of it by a monkey wrench falling in it. The wheel was 12-in. face, 90-in. diameter.

I chipped off the face of the wheel smooth where the teeth were gone. Then I laid off the places with dividers where the teeth should have been, center punched, drilled and tapped 4 holes 1 in. in diameter for each tooth, then made studs out of soft steel (so as not to cut companion wheel), screwed them in tight and put lock nuts on back or inside of wheel, shaped up studs and dressed them with a file. This was 4 yr. ago, and the job is still standing up.

FRED V. BROADAWAY.

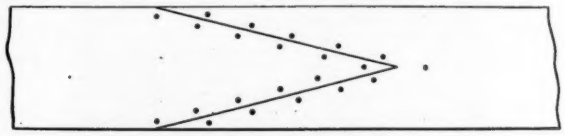
WHEREVER THERE are data to record, inferences to draw or facts to tell, a graphical presentation is the most convincing means.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Peculiar Belt Joint

A 6-IN. HIGH SPEED belt was run in a wet place and I could not keep it glued. When I laced it with a square cut joint it would keep all the oil jarred out of the journals, so I used the method illustrated which I found did a great deal better, and I am using it now in bad places. When making this kind of joint, measure the belt and get the exact center for the pointed end. Then measure down as far as you are to make the joint, mark belt, cut the pointed end, then put the pointed end over the other end and mark it. This will make a perfect joint. Next take a square lengthwise of the belt and mark off your holes so lace will be straight with the belt. I get smoother running bearings this way when belts are tight and high-speed. I have used it on dynamo belts (6-in.) that gave much better satisfaction, as



V-SHAPED BELT JOINT

it kept the lights from flickering as the joint with the old way went over small pulley. When lacing the joint, start in the center of the belt and lace each way.

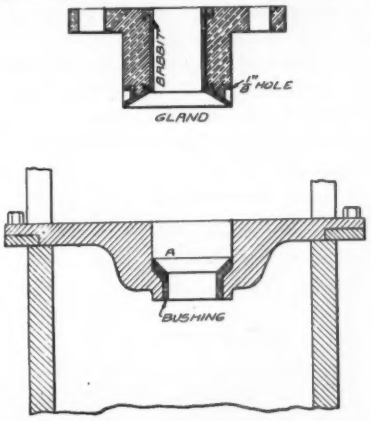
When putting on new belts, that is, laced joint belts, they should be pulled tight when new, then cut 6, 8 or 10 in. short, cut depending on the length of the belt. Lace in a piece to make proper length as belt stretches. Take out the piece and substitute one shorter each time the belt needs shortening. Finally when the belt gets stretched out, you can lace the joint together without any piece in the joint.

I always have pieces returned to the store room when taken out of the belt. By this method, you will not have to have new belt quite so long (which is a little saving) nor waste any new belt by cutting it off each time when lacing it. FRED V. BROADAWAY.

Repairing Worn Piston Rods

IN VISITING a fellow engineer's plant I noticed that his boiler feed pumps worked at a shortened stroke and that they labored hard at the end of the strokes. About every half hour the oiler would swash the steam end rod with cylinder oil, then for a few minutes the pump would run easier. He told me he had the same trouble with all 4 of his feed pumps, and after examining those that were idle, I found that worn rods, combined with old packing set up excessively tight, was the cause of his trouble. I suggested the following plan to him, which cured his trouble and saved expense:

He purchased one new rod from the makers of the pump, removed the old from the pump giving the most trouble, and installed the new one. While the pump was apart, the measurements of the stuffing-box and gland were taken, the old rod turned true and bushings shown in the sketch made; the next pump's worn rod was taken out and this re-trued rod put in its place; bushing A was placed at the bottom of the stuffing-box, and the next size packing was used to fill the increased volume caused by turning down the rod. One-sixteenth inch cut was



METHOD OF BUSHING STUFFING BOX AND GLAND

taken off the rod, reducing its diameter ⅛ in. The packing gland was drilled in 2 places and turned at the top, as shown; a mandrel the same size as the reduced pump rod was made, the gland was placed in a mold made of fire clay, the mandrel in the center and the gland babbited, as shown in sketch. This method was repeated on the other pumps; at the finish it gave one spare rod. C. H. W.

Gunpowder to Clean Chimneys

HOW A CHARGE of powder may perform useful service in clearing industrial chimney stacks from soot is told by S. R. Russell in an article entitled "Shooting Soot from Stacks," contributed to The Du Pont Magazine.

"A simple, economical, and most efficient method to accomplish this is to shoot the stack with the 'stack gun' and blasting-powder. This gun can be used in cleaning either lined or unlined stacks, brick or steel, without any fear of injury to the stack or lining.

"The gun can be made out of an old piece of shafting about 4 in. in diameter and 14 to 16 in. long. Bore a hole 1¾ in. in diameter and 10 in. long in the center of the piece. Then bore a small horizontal hole ¼ in. in diameter through the piece to the bottom of the center-bore. This hole serves as a touch-hole for inserting the fuse.

"The whole thing can be mounted on a pedestal about 6 in. in diameter so that it will stand in an upright position.

"The method of operation is as follows: Pour some FFF blasting-powder into the mouth of the cannon to about 2 in. from the top. Tamp to the collar with dry clay. A short piece of fuse is inserted in the touch-hole and in contact with the main powder-charge. Open the flue-door at the bottom of the stack, set the cannon on the bottom and in the center of the stack, light the fuse, and close the flue-door.

"The explosion shakes and loosens the soot adhering to the sides, causing it to fall to the bottom. It can then be removed through the flue-opening.

"A charge of 8 in. of FFF powder, 1¾ in. in diameter, is sufficient for a stack up to 100 ft. high and 4 ft. in diameter, or over. The number of shots necessary to clean a stack thoroughly depends upon its condition. Ordinarily, 3 or 4 shots will clean a stack, but if very dirty it may require more. The size of the charge and length of the cannon can be regulated to suit the height and diameter of the stack.

"There is no doubt about the efficiency of this 'gun' for cleaning smokestacks. One of the largest manufacturing concerns in the country has used this method for several years, without an accident or injury in any way to the stacks."

Replacing a Worn Keyway

THE FOLLOWING repair job may be of interest to readers. The key in one of the driving wheels of an overhead traveling crane worked loose, and as it could not come out altogether, owing to the fact that one of the bearing brackets that are at each side of the wheel seat interfered, the keyway wore so badly that it was impracticable to dress it up and fit another key in it. As there were no spare wheels or shafts, it was decided to make the best of it. The keyway in the boss of the wheel

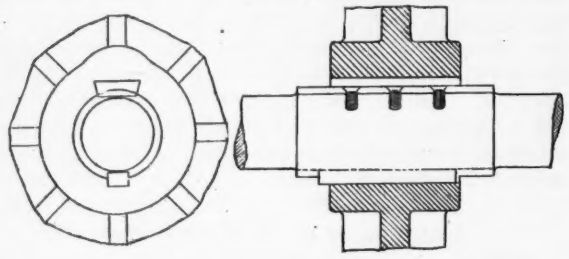


FIG. 1 FIG. 2

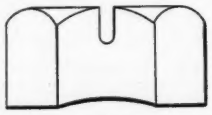
FIG 1. METHOD OF SLOTTING KEYWAY

FIG. 2. SCREWS HOLDING STEEL PIECE IN SHAFT KEYWAY

was slotted out and dovetailed, as shown in Fig. 1, and a piece of steel fit in and driven home tight and then slightly riveted over at each side of the boss, the surplus inside the hole being slotted out to the diameter of the hole. Likewise a piece was fitted in the shaft and fastened with 3 screws as shown in Fig 2, the screws being riveted over and the piece dressed level in the lathe with the diameter of the shaft. A new keyway was cut opposite the old one, and a key fitted in; and needless to add, it lasted a long time, ultimately being replaced with a new wheel and shaft.—X. Y., IN THE POWER USER.

Easily Made Lock Nut

IN A recent issue of Mechanical World, P. N. C. describes a lock nut which he states he made many years ago. The nut was split across as shown in the

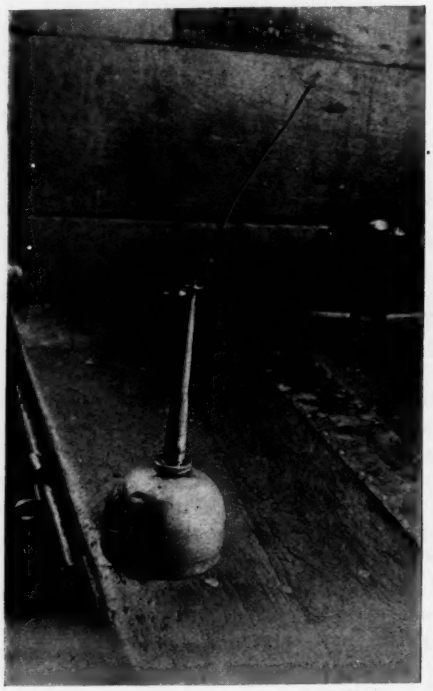


LOCK NUT MADE WITH HACK SAW AND HALF-ROUND FILE

accompanying illustration, and on the face a shallow recess was formed by using half-round file. As the nut was tightened, the 2 side portions were forced up, causing the upper part to grip the screw.

Extending the Oil Can Spout

RECENTLY the writer had some machinery to look after, in connection with which some small oil cups were so located from the manner in which other parts were necessarily situated, that it was a difficult task to get oil into the cups with almost any kind of a small straight or curved oil can spout.



WIRE EXTENSION ON OIL CAN SPOUT

The photograph shows how a piece of copper wire was bent with an eye in one end which dropped down and tightened over the taper of the spout. The oil then followed the wire, if not allowed to flow too freely, dropping directly into the small cups no matter where located.

F. W. BENTLEY, JR.

A FIRM IN United Kingdom desires to secure wrought iron and steel pipes and fittings for water and gas service. Information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, D. C., inquiring for No. 23,066.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Air Compressor Problem

How can a steam-driven air compressor having dimensions of 10 by 10 by 10 in. and taking steam at 85-lb. pressure, deliver air to the receiver at 100-lb. pressure? Steam and air cylinders being the same size, why will the air pressure exceed that of the steam by 15 lb.?

T. L. H.

A. To explain this we would state that the mean effective pressure in the air cylinder must be less than the mean effective pressure in the steam cylinder, thus giving the advantage to the steam cylinder sufficient to overcome all friction of the machine.

You will note that the indicator card taken from the air cylinder is quite similar to that taken from a steam cylinder. The discharge line on an air compressor card corresponds to the steam line on a steam cylinder card, so that the discharge line on the air card represents the discharge pressure, or, in your case, 100 lb., and will be approximately 1/6 the length of the air card, while your steam cylinder card has an initial pressure of 85 lb., and cutoff will occur in the neighborhood of half stroke or further, giving a greater mean effective pressure in the steam cylinder than in the air cylinder. When no flywheel is employed, the air compressor must take steam full stroke as does a direct acting pump.

The power delivered, therefore, by the steam cylinder is more than that absorbed by the air cylinder. This, we believe, will make clear the problem you present.

R. E. T.

Determining Velocity of Pump Discharge

What will be the velocity of water in the 3-in. discharge of a pump having a 6-in. piston which travels at the rate of 100 ft. per minute?

2. How would you determine the size of steam header required for a battery of boilers?

3. How would you change the cutoff on a slide-valve engine from ⅝ to ¾ in. without altering any of the other valve functions?

R. S.

Answers

Assuming that the pump piston moves continuously at a speed of 100 ft. per minute, the velocity in the pipe will be inversely as the square of the diameters. Since the pipe diameter is ½ that of the piston, the velocity will be 4 times as great in the pipe as in the pump cylinder, or 400 ft. a minute.

2. A steam header for a battery of boilers should have an area practically equal to the combined areas of the mains leading from the boilers. If you have 3 boilers, each with a main 6 in. in diameter, the diameter of the header would be equal to the square root of the product of 3 times 6 squared. This would give a diameter of 10.4 in. A 10-in. pipe would be large enough, since the area does not have to be quite equal to the sum of the areas of the mains.

3. In regard to the question on the slide valve change, there would be no possible way of changing the cutoff from ⅝ to ¾ without changing other functions of the valve, unless the valve itself be changed. For instance, if we have a valve with 3-in. travel, cutting off at ⅝ stroke, the lap would be about ¾ in.

If we want to change this to a cutoff at approximately ¾ stroke, we would have to cut the lap to ⅝ in., and then turn the eccentric back until the lead was the same as before. This would be properly about 5/16 in. for both conditions. The exhaust lap would likewise have to be changed in order to bring release and compression at the same points as before.

A. L. R.

Utility of Steam Cushions

What prevents a pump piston from striking the cylinder head?

Reader.

A. As the piston nears the end of the steam cylinder, it covers the exhaust port at that end thus imprisoning a small amount of steam which being compressed by the advance of the piston actuated by steam on the other side, acts as a cushion. The early types of duplex pumps were exceptionally extravagant in the use of steam, but experience has refined designs so that today duplex pumps run with a striking clearance as low as ⅛ in. When the steam end of a duplex pump approaches 10 or 12 in. in diameter, there is inserted a cushion valve between the 2 ports at either end of the cylinder, so that the steam imprisoned in the end of the cylinder can be allowed to bypass into the exhaust port through the cushion valve. In this way, only enough exhaust steam need be retained to cushion properly the reciprocating parts.

G. H. Wallace.

Pump and Boiler Questions and Answers

How can I test a pump for packing leakage?

2. Why is one side of a duplex pump valve direct and the other side indirect?

3. What is a self-contained boiler?

4. What is a dry sheet in a boiler?

C. J.

Answers.

One method of testing a pump for leakage of the packing is to block the piston in a fixed position,—say mid-position, and then open the steam valve. Next, open the drip cock at the end toward which the piston was advancing, and any leakage past the steam piston will blow through the open drip. Leakage of the water piston may be detected by removing the head after blocking the suction valve at that end and slowly operating the pump single-ended.

2. By studying any of the ordinary designs of pumps, it will be noted that on one side motion is communicated from the piston rod to the valve stem in such a manner that the 2 move in the same direction. On the other side, however, the connection is such that the valve is moved in the opposite direction to that in which the piston is traveling.

The side on which the valve moves in the same direction as the piston that drives it is called the direct side, while the side on which the valve moves in the opposite direction from the piston which drives it, is called the indirect side.

The necessity of having such "direct" and "indirect" forms of valve motion is due to the form of construction of the valve mechanism used on the ordinary duplex pump.

3. A self-contained boiler is one that is internally fired.

4. In the flush front horizontal tubular boiler, the smoke box at the front end of the boiler is over the fire doors, and the part of the sheet which extends beyond the front head is called the "dry sheet." This is not protected by water on the upper side, but has a firebrick lining on the under side to protect it from the heat of the furnace. W. P.

Injector Operation

CAN AN INJECTOR taking steam from one boiler deliver water to another boiler operating at a higher pressure? N. R. W.

A. An injector can force water into another boiler than that from which it draws its steam, at a pressure higher than the steam pressure operating the injector. This is simply a matter of design of the injector, and proportioning the size of the steam nozzle to the delivery nozzle.

For instance, steam at 40 lb. pressure discharging through the nozzle has a free velocity of 2000 ft. per second. The head corresponding to 40 lb. pressure is about 92 ft., and would give a jet velocity for water flowing from the boiler of 77 ft. per second.

A pound of steam would, therefore, be able to give to 9 lb. of water, a velocity of some 200 ft. per second, which obviously would overcome a much greater pressure than 40 lb. A. L. R.

Transformer Operation Questions

IN OUR lighting plant, we have a number of single-phase transformers designed to step down the voltage from 440 to 220, or 110 v. The secondary windings of these transformers are each made up of 2 coils which may be connected in series or parallel. Will connecting these coils in series give 220 v. across the 2 outside lines? Will parallel connection give 110 v.? If, with the series connection, a neutral is joined to their point of connection, will the voltage between this neutral and either outside line be 110?

2. What effect will increasing or decreasing the resistance of the secondary windings have upon these coils and upon the machines supplying the transformers with current? What would be the result of short-circuiting the secondaries? C. S. W.

ANSWERS

IT IS general practice, at the present time, to provide low voltage light and power transformers with 2 sets of secondary windings, whereby it is possible to obtain either one of two, or both voltages.

You are correct in assuming that by connecting the two secondary coils in series you will be able to obtain a voltage of 220 across the two outside lines, and a voltage of 110 across the center, or neutral, and either one of the two outside lines.

2. The only noticeable effect of increasing or decreasing the resistance of the secondary winding would be to change the current capacity of these coils. Naturally, by increasing the resistance, the current carrying capacity would be reduced, and by decreasing the resistance, it will be possible to carry more current in these windings.

The only possible effect which such a change may have upon machines supplying these transformers would be either to increase or decrease their load.

Short-circuiting the secondaries of any transformer will, of course, result in an excessive flow of current, and will either blow out the primary fuses or, if this should fail, burn out the transformer. As a consequence, the machine would be carrying a somewhat greater load during this time. O. H. H.

Making Smoke Observations

PLEASE EXPLAIN in detail the different methods of making smoke observations. S. R. B.

A. No wholly satisfactory methods for smoke determination have yet come into use.

One method commonly employed which answers the purpose fairly well, is that of making frequent visual observations at intervals of 1 min. or less for a period of 1 hr., and recording the observed characteristics according to the degree of blackness and density, and giving to the various degrees of smoke an arbitrary percentage value rated in some such manner as that expressed in the following table:

SMOKE PERCENTAGES

Dense black	100
Medium black	80
Dense gray	60
Medium gray	40
Light gray	20
Very light	5
Trace	1
Clear chimney	0

The color and density of smoke depend somewhat on the character of the sky or the background, and on the air and weather conditions when the observation is made, and these should be given due consideration in making comparisons. Observations of this kind are also subject to personal error and errors of judgment.

Professor Ringelmann, of Paris, has invented a system of determining the relative density or blackness of smoke. In making observations of the smoke proceeding from a chimney, 4 ruled cards, together with a card printed in solid black and another left entirely white, are placed in a horizontal row and hung at a point about 50 ft. from the observer and as nearly as convenient

in line with the chimney. At this distance the lines become invisible and the cards appear to be of different shades of gray, ranging from very light gray to almost black. The observer glances from the smoke coming from the chimney to the cards, which are numbered from 0 to 5, determines which card most nearly corresponds with the color of the smoke and makes a record accordingly, noting the time. Observations should be made continuously during say 1 min., and the estimated average density during that minute recorded, and so on, records being made once every minute. The average of all the records made during a boiler-test is taken as the average figure for the smoke density during the test, and the whole of the record is plotted on cross-section paper in order to show how the smoke varied in density from time to time. A rule by which the cards may be reproduced is given by Professor Ringelmann as follows:

Card 0—All white.

Card 1—Black lines 1 mm. thick, 10 mm. apart, leaving spaces 9 mm. square.

Card 2—Lines 2.3 mm. thick, spaces 7.7 mm. square.

Card 3—Lines 3.7 mm. thick, spaces 6.3 mm. square.

Card 4—Lines 5.5 mm. thick, spaces 4.5 mm. square.

Card 5—All black.

E. P. Roberts, Smoke Inspector of Cleveland, Ohio, has invented 2 types of smoke charts which are claimed to be more convenient in operation than the Ringelmann chart. They consist of disks of cardboard having radial black lines on a white background. When a disk is revolved a series of tints appear, ranging from white at the center to black at the edge. They are spun by hand while supported on a brad-awl or other convenient spindle, an eyelet center being provided in the disk for that purpose. One of the charts, when spun, shows a series of rings corresponding to smoke densities of 20, 40, 60, 80 and 100 per cent. W.P.

Charging and Care of Automobile Batteries

I DESIRE to charge a 6-v. storage battery used for automobile starting service, by means of current taken from a 21-amp., 120-v., direct-current generator.

How can this be done, and what time would be required to bring the battery up to normal or full charge if more than half discharged? Would you add any dilute sulphuric acid if the solution is too weak to give the proper hydrometer reading? C. J. T.

A. Charging a 6-v. battery from a 120-v. circuit is, at best, a wasteful operation, since enough resistance must be put in series with the battery to take up 114 v.

The way to do this, if it is deemed desirable, is to put a lamp bank in series with the battery, using 110-v. lamps in parallel, and turning on a sufficient number so that the voltage across the terminals of the battery will be a little over 6 v.

You do not state what the amperage of your battery is, and care should be taken that the charging current does not exceed the safe amount for the battery, as otherwise it will produce boiling and gassing which is injurious to the plates.

As a rule, it is best take 8 hr. for the charge, with a battery that is half discharged, the rate of charge being regulated by the amount of current sent through it. The charging can be begun and carried on for, say, 6 hr., at a comparatively high rate, then the amount of current should be reduced and carried on at about a normal discharge rate for 2 hr. or more until the battery is up to full voltage on open circuit.

Under no circumstances should sulphuric acid be added to bring up the weak solution, unless voltmeter test shows that the battery is up to full voltage. The solution will run down in strength with the discharge of the battery, and will build up in strength as the battery is charged. Increasing the specific gravity of the solution by adding extra acid does not help the condition of the battery at all. A. L. R.

Calculating Engine Horsepower with Switchboard Instruments

THE ENGINE in my charge is direct-connected to a 2300-v., 3-phase alternating-current generator.

With the switchboard ammeter indicating 75 amp. and a power factor of 0.85, what is the approximate horsepower developed by the engine? Kindly indicate fully how this may be calculated. F. B.

A. The most accurate manner to determine the horsepower developed by any steam engine is by means of the indicator. When, however, such an instrument is not available, it is possible to determine, at least approximately, the horsepower delivered by means of the switchboard readings, allowance, however, being made for the efficiency of the unit.

The power delivered by any 3-phase alternator may be expressed by means of the following formula: $P = \sqrt{3}\,E\,I\,(P.F.)$. Where P is the power, expressed in watts; E, the electromotive force across any 2 lines; I, the current flowing in any single line, and (P. F.) the power factor, expressed as a decimal.

We assume that the reading of 75 amp. which you mention is the current flowing in one line. We, therefore, have $P = \sqrt{3} \times 2300 \times 75 \times 0.85 = 257{,}121$ w., which reduced to kilowatts will give us 257.12.

As one kilowatt is equal to approximately 1.3 electrical horsepower, the power developed by the generator, expressed in electrical horsepower, is 334.25. Let us assume an over-all efficiency of the generating unit of 80 per cent; in which case the horsepower developed by the engine would be 417. O. H. H.

Calking a Gasoline Tank

PERHAPS some reader of Practical Engineer will be kind enough to answer this question for us: What should be a safe way to calk a cylinder tank (made of 5/16-in. steel and riveted with 5/8-in. rivets), which contains casing head gasoline of 86 deg. Baume, under a pressure of 15 lb. per square inch? W. E. C.

Oil Filtering Methods

HAVING SEEN several articles on filtering oil, I would like to learn whether any of the readers have filtered oil from an oil extractor and used it again in a steam cylinder? If so, is it satisfactory? F. O. B.

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Profitable Service in Industrial Power Plants

Much time and thought are expended in these days by central station men upon securing profitable business, whether of the off-peak, long-hour or diversified variety. The entrance of central-station service into many a local power situation depends upon the skill with which such opportunities are analyzed. The operating engineer, particularly in the industrial plant, hears more or less of the advantages of going after profitable work. His own employers concentrate as far as possible upon those lines of products which can be turned out with the maximum profit; he sees the efforts of central station solicitors to capture business of the most profitable kind, and sooner or later turns the inquiry back upon himself as to what he can do as a progressive engineer toward utilizing his own installation to the highest reward of its owners.

To such an engineer the time has passed when it is sufficient to accept the demands which come upon the installation without question as to their effect upon operating economy and to devote week after week merely to meeting those demands as well as he can with the equipment combinations under his control. Without being officious, the engineer in the right kind of an organization may well take up the study of service in his establishment in relation to the mutual requirements of the generating plant and of the various mill departments. This investigation will cover the time and periods of the various demands for industrial heat, power supply, lighting, ventilation, and overlaps of the various classes of service will be noted in relation to the station output curves. These may include graphic records from wattmeters, steam flow meters, pressure gages and perhaps plots of hot water supply rates, with the charting of logs of station equipment use, occurrence of excessive "pulls" on units due to irregularities in consumption, or to unplanned use of particular services.

When the foregoing types of data have been assembled and analyzed in relation to plant service, it will often be seen where slight changes in the handling of equipment in the mill would result in substantial savings in the generating station. Now, in some cases, these changes cannot be put into effect without increasing the cost of the main manufacturing processes more than they save in the power plant; but the point is to find out whether this is likely to be the case or not. Here is where a live efficiency committee of which the chief engineer of the power plant is a member can do a lot of good work. Without treading on one another's toes, conferences can be held between department heads, foremen and other officials at which the practicability of a revised scheduling of demands upon the plant may be considered. In one case, it may appear that the use of flywheels upon more direct-driven machine tools will pay in decreased coal consumption at the generating station; in another instance, a rearrangement of the hours during which certain long-period heating processes take place may enable the station service to be more efficiently handled. In studies of this kind, the operating engineer is sure to learn a great deal that is worth while about the use of his plant's product in the larger establishment, and with proper backing, the latter can be put on an efficiency basis which will challenge the records of central station economy.

Editorial Comments

Much interest has been displayed by engineers in the preparedness of our country against inroads of a foreign power, yet comparatively little is known by the outsider in regard to the equipment of the government forts. This is due principally to the restrictions placed upon visitors to these forts and those who have charge of them. In this issue, however, a detailed description of the equipment, operating record and force employed at the Fort Sill power plant is published, which leads to the conclusion that a power plant for an army fort is in no essential different from an isolated plant for an industrial concern or an institution which depends upon the power plant for all the services it is capable of rendering with modern equipment. Reliability comes first, economy second.

Can there be any more important factor in the operation of a steam engine than the lubrication of the cylinder? For many years the progress in the development of steam power was hindered, almost stopped, for the want of a lubricant suitable for engines using steam of what today is called moderate temperatures. Mr. Battle's article upon the subject will make clear to readers what the difficulties are that present themselves in cylinder lubrication and how they have been overcome.

Improved to the point where the original instruments would hardly be recognized by a modern engineer and its uses multiplied, the steam engine indicator stands today the most valuable aid to engineers for maintaining highest economy in operation. The third and last article of the series dealing with this subject appears on another page, where several of the modern instruments are described in detail and directions for taking care of them are given.

Many improvements have been made in steam condensers during recent years, much experimenting has been done, the laws of heat transfer have been more definitely established, operating difficulties have been analyzed and met more successfully, all of which lead to changes in proportions from those formerly employed. In the article on Proportioning of Surface Condensers, the formulas used by Mr. Orrok, in designing surface condensers are given, which take into account recent investigations.

While being carried to the top floor of a skyscraper little do we stop to figure what the ride has cost the building management; nor do we estimate what it has cost when through thoughtlessness we have caused an elevator to stop, then changing our desire have it go on without us. These are some of the things discussed by Mr. Watson in his article on traction elevators.

To the mind constantly dealing with mathematical formulas and abstract ideas, graphics are mere play and of little value, but, to most of us, a graphical representation of a formula or the movement of an element of a machine with respect to other elements gives a vivid conception of the involved relations which can be reached in no other way. Those who are not thoroughly conversant with alternating current phenomena will be given a means for picturing mentally what current relations take place in single, two and three-phase circuits by reading Mr. Roux's article.

Rapid strides made in the development of internal combustion engines have brought upon the market a variety of types from which to choose the engine, best suited to the service. Valuable information to aid in the problem of selecting a tractor engine is given in this issue under the title Internal Combustion Engines as Applied to Tractors.

Now that Congress is in session interest is turned once more to Washington and the activities of our representatives, particularly in regard to those measures that deal with engineering problems and power development. Mr. Connor, in his article on News from Washington, reviews various topics of national interest and points to things that are likely to be subjects of discussion.

In lieu of an instrument for determining heat value of coal direct, it is natural to resort to mathematics and the chemical analysis of the fuel. Dulong's formula, based on ultimate analysis, gives a result which is considered accurate, but to make an ultimate analysis requires instruments and skill not frequently found in power plants. The proximate analysis, on the other hand, is easily made, but mathematical formulas using this analysis have not heretofore been developed which would give sufficient accuracy in all cases to warrant a general use. In this issue, however, Mr. Schaphorst presents a formula and chart for which sufficient accuracy is claimed to make it of general use. Try it out on your coal.

Some live questions are discussed in letters received from operating engineers, and among the kinks are a variety of ideas workable in nearly all plants which power plant men should know about.

Questions and answers published in this issue are of particular value to the operating engineer, and the variety is as great as the colors in a crazy quilt.

Don't miss the Practical Reference Tables, which, this time, are mostly charts for rapid calculation of engineering problems, formulas graphically expressed and easily used.

In an article on the Effects of Vibration in Structures, by the Aberthaw Construction Co., mention is made of the harmful effect of vibration in buildings on the morale of the working force, and on the condition of machines operated where there is much vibration of the floors. Also, attention is called to the waste of power due to the vibration of floors from which line shafts are suspended. Vibration due to lack of rigidity in the building not only results in sagging, which makes the maintenance of the shaft in alinement difficult, but also results in vibration of the shafting, which increases bearing friction and a strain on the shaft. In some cases, the deflection of floors has been sufficient to make necessary shortening of belts.

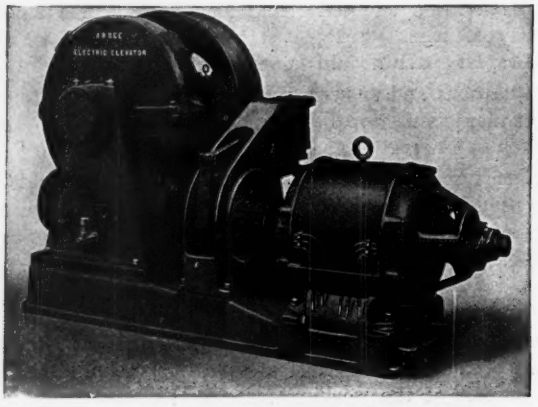
One method of avoiding the vibration of machinery is the use of rubber pads between the machines and the floors, this having been found to cut down the crystallization of the parts of the machines, which in many cases has resulted from vibration. It is found that, as a rule, the reinforced concrete structure is much less likely to harmful vibration than either the mill construction building or the monolithic concrete.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Two-Speed Alternating-Current Elevator Motor

THE 2-speed alternating-current motor illustrated herewith is designed for operating high-speed elevators. Until recently, the speed of the car for an alternating-current elevator equipment was limited to from 200 to 250 ft. a minute owing to the necessity of using single-speed motor. This limitation of speed was due to the fact that in slowing down for a stop, an alternating-current equipment with a single-speed motor had to be stopped by a mechanical brake. On a direct-current outfit with field control, slow-down and dynamic braking are employed. By the use of the 2-speed alternating-current motor, a car speed of 400 ft. a minute is now possible, and starting and stopping is accomplished as smoothly as with an equipment driven by a direct-current motor.



WESTINGHOUSE TYPE CI 2-SPEED ALTERNATING-CURRENT ELEVATOR MOTOR AND EQUIPMENT

The unique feature of this 2-speed alternating-current motor, which is made by the Westinghouse Electric & Manufacturing Co., is the use of 2 separate windings in both stator and rotor. Mechanically, the construction of this type of motor is the same as that of the standard single-speed CI elevator motors made by the same company. Special attention has been paid to securing quiet operation so essential for apartment house, hotel, and office building service. The motor develops a high torque at low speed with a starting current only 50 per cent above the current at full speed with full load.

For starting, a 24-pole connection is used, giving a motor speed of 250 r.p.m. When the motor attains sufficient speed the connections are changed to give 8 poles, and the motor then comes up to a speed of about 850 r.p.m. In slowing down, the 24-pole connection is again employed. At the instant this is done, the motor is running at a higher speed than the synchronous speed for this connection. As an induction motor driven above synchronism acts as a generator, this produces an electrical braking action that quickly brings the motor speed down to synchronism. Then by disconnecting the motor from the line and applying an electrically operated mechanical brake, the car is easily brought to rest. Both rotor windings are connected to the same slip rings so that but 3 collector rings are necessary. In operation, the 8-pole rotor winding responds only when the 8-pole stator connection is made and the 24-pole winding is only active when the stator is connected for 24 poles.

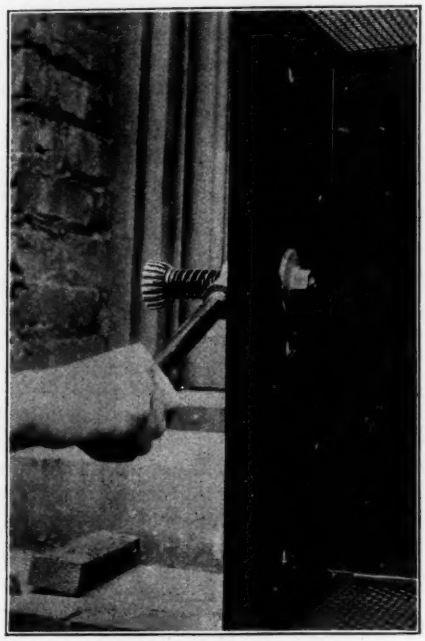
This line of 2-speed alternating-current elevator motors permits the use of alternating current for high-speed elevator service, and eliminates the loss in transmission, heretofore unnecessary, where direct current is not furnished by the central station. Twenty-five, 30, 35 and 40 hp. are the standard sizes of these motors.

The controller employed consists of a number of magnetically operated switches and relays mounted on a slate panel and operated by a car switch located in the elevator car. When the car switch is thrown to either the full up or down position, the controller connects the low-speed motor winding to the line with resistance in the rotor circuit. As the motor accelerates, this resistance is automatically cut out by magnet switches, whose rate of operation is controlled by series current limit relays, bringing the motor up to the full speed of the low speed winding. A change-over switch then closes, opening the low-speed winding and impressing voltage on the high-speed winding with resistance in the rotor circuit. This transition is made so smoothly that it cannot be noticed in the elevator car. The resistance is then cut out automatically as above, bringing the motor and car to full speed. Both acceleration and retardation are accomplished smoothly, without any shock or jar in the car. The car switch provides for 2 running speeds in each direction. The same safety devices, such as hatchway and car-limit switches, slack cable switches, and emergency car switch, used with high-speed elevators driven by direct-current motors, can be used with this equipment.

ACCORDING TO recent report from the Bureau of Foreign and Domestic Commerce, it has been possible to obtain power in some localities in Norway at less than $5 per horsepower year, and in one case at nearly $2.50. Capital invested in the ammonium nitrate industry alone amounts to over $40,000,000, and the industry produces about 150,000 tons of fertilizer a year.

New Handy Operating Cutter

THE usual way for making an additional hole in a cabinet for accommodating a piece of conduit or for making a hole in metal lockers or enclosing cases, has been the source of considerable trouble. A new easily operated tool has been invented (patent applied for) by a Milwaukee man, Mr. Bach. This device can be used for cutting all sorts of metal, fiber and slate, and can be adjusted so as to cut holes of various sizes with little effort and in but a few moments. To use the tool, all that is necessary is to drill a pilot hole through the material and through this the stud is passed. A flange nut is then secured on the opposite side of this stud and a few operations of a ratchet wrench cuts out a



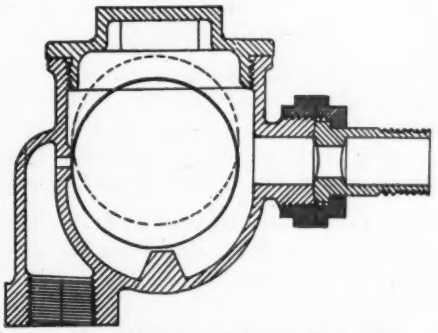
USE OF "JIFFY" CUTTER

neat hole. A test conducted recently showed that for a standard conduit cut-out box (wall about 0.1 in.) 14 revolutions of the knives sufficed to cut a hole and the time required was less than a minute. The accompanying illustration shows one of the uses of this appliance. The knives which may be adjusted for cutting holes of several diameters are held in a swing chuck and are automatically fed by means of the spring shown between the swing chuck and the sham nut. This device does the work of a 6-in. drill press and it is particularly desirable because it can be taken to the work, rather than having the work brought to it. In the case of a tank where the flange nut cannot be secured to the stud on the inside it is only necessary to tap the pilot hole and insert the stud into this hole. While but a few of the uses are mentioned above, the inventor claims that this tool is useful in the automobile garage, boat building plant and in fact in every industrial works.

The "Jiffy" cutter described above is now being manufactured and marketed by The Universal Tool & Appliance Co., a new company located in the Stroh Industrial Bldg., Milwaukee, Wis.

Ball Operated Radiator Trap

AN interesting development in economical heating was shown in a recent test of the J-M radiator trap, a new and modern trap now being marketed by the H. W. Johns-Manville Co., which operates on the same principle as the J-M steam trap. It is found that the Roger Morris Apartment of New York City, in which 502 J-M radiator traps are used on the radiators and on the drips of risers, can be heated with a half-pound gage pressure when the temperature outside is 10 deg. F. When the gage hovers around zero the radiators on the top floor are hot.



JOHNS-MANVILLE RADIATOR TRAP

This trap can be used on any radiator connected on a 2-pipe heating system, and under any pressure ordinarily met in heating up to 10 lb. It will take care of the condensation from any radiator having a heating surface of 250 sq. ft. or less. There are but 3 parts—the body, connecting union and the rolling ball. The hollow, seamless unattached copper ball covers the discharge orifice and prevents the loss of steam. When condensation enters the trap the ball rolls up, exposing the discharge opening, which permits a discharge of water and air without the loss of steam. The discharge is constant and automatic.

Condensite-Cellulac

A NEW form of electrical insulation, called Condensite-Cellulac, of general interest and wide application throughout the electrical industry, is now being placed on the market by the Diamond State Fibre Co., Bridgeport, Pa.

Condensite-Cellulac is permanently anhydrous and non-hygroscopic, is impervious to the action of oil or ordinary acids or solvents, is infusible and is not affected by the action of heat within the range of temperature ordinarily encounter, hence cannot break down. It is tough and will stand considerable vibration or shock.

As it is strictly weatherproof, this material may be used advantageously in apparatus which is to operate under unfavorable conditions of moisture, or subject to splashing with oil, such as insulation for automobile ignition systems, or where exhaust steam is used in industrial processes.

Condensite-Cellulac is furnished to the trade in sheets, rods, tubes, etc., and is readily machined. It may be formed into very thin sheets (0.015 in. or less) with remarkable accuracy to gage, thereby furnishing an

excellent diaphragm material. It is also supplied shaped to customers' specifications, ready for use, having been hardened and made insoluble and infusible by the application of heat.

An unique feature of Condensite-Cellulac of considerable general interest is the possibility of supplying it in the soft uncured state, permitting of its being hardened in the place where it is to be used and thereby formed to fit in spaces or locations with an accuracy not otherwise possible. Thus gaskets for steam, hot water or compressor air lines may be accurately fitted to rough flanges and cured in place by the heat of the line.

News Notes

THE TENTH ANNUAL CEMENT SHOW will be held by the Cement Products Exhibition Co., in the Coliseum and Annex, Chicago, Feb. 7 to 15, 1917. The exhibit will cover all kinds of cement products and machinery used for constructing cement work of every description.

THE NEW ADDITION to the plant of W. H. Nicholson & Co., located at Wilkes-Barre, Pa., which has been under construction for some time, is now completed. The required machinery is already on hand and is now being installed. The addition will increase the floor space about 100 per cent.

THE LAGONDA MANUFACTURING CO., of Springfield, O., announces the opening of a new Branch Office in the McCormick Bldg., Chicago, Ill. J. E. Chubb, formerly with the Griscom-Russell Co., is in charge, as district sales manager, of the company's business in this territory, which was formerly in charge of the Chicago Engineer's Supply Co.

U. S. CIVIL SERVICE COMMISSION announces an open competitive examination for laboratorian, qualified in strength of materials, on Jan. 3, 1917, to fill a vacancy in the position of laboratorian, at $3.04 a day, in the navy yard, New York, N. Y., and vacancies as they may occur in positions requiring similar qualifications at any navy yard or other naval establishment of the United States or in the Department at Washington, D. C. Competitors will be examined in the following subjects: Theoretical and practical questions in physics, mechanics, and strength of materials, training and experience; they must show graduation from a 4-yr. high-school course, or 4 full years of study in a school offering a course equivalent to that of a high school, and must show specifically that their course comprised at least 1 yr. of physics and mechanics, and at least 1 yr. of laboratory experience involving a knowledge of the strength of materials, which may have been gained in the testing department of manufacturing concerns or in the laboratory of a technical school. Applicants must have reached their twentieth birthday on the date of the examination.

U. S. CIVIL SERVICE COMMISSION announces an examination for junior petroleum engineer, on Jan. 3, 1917, to fill vacancies in the Bureau of Mines, Department of the Interior, for service in the field, at salaries ranging from $1200 to $1500. Graduation with a degree in engineering from a college or university of recognized standing, and at least 6 mo. experience in connection with engineering problems, are prerequisites for consideration. Applicants must have reached their twenty-first but not their thirty-fifth birthday. Apply for Form 1312.

U. S. CIVIL SERVICE COMMISSION announces examinations for Dec. 26, as follows: (1) Petroleum Economist, (2) Petroleum Accountant, to fill vacancies in the Bureau of Mines, for service in the field, at salaries ranging from $1800 to $2500 a year. Applicants for either examination must have reached their twenty-first but not their fortieth birthday on the date of the examination, and must apply for Form 2118, stating the title of the examination desired.

U. S. CIVIL SERVICE COMMISSION announces an examination for junior petroleum technologist on Jan. 3, 1917, to fill vacancies in the Bureau of Mines, Department of the Interior, for service in the field, at salaries ranging from $1200 to $1500, duties being to assist in investigating various problems in the technology of oil and gas production. Graduation in geology from a college of recognized standing, and at least 6 mo. experience in actual work in an oil and gas field are prerequisites for consideration. Applicants must have reached their twenty-first but not their thirty-fifth birthday. Apply for Form 1312.

U. S. CIVIL SERVICE COMMISSION announces an examination for transitman, on Jan. 3, 1917, to fill vacancies in the Forest Service, for duty in the field, at salaries ranging from $800 to $900, and vacancies as they may occur, duties being to assist the chief of surveying parties in making surveys of lands being acquired under the Weeks law. At least one year's practical land-surveying experience, of which not less than 6 mo. must have been spent in the position of transitman, is a prerequisite for consideration. Applicants must have reached their twentieth but not their thirtieth birthday. Apply for Form 1312.

Book Reviews

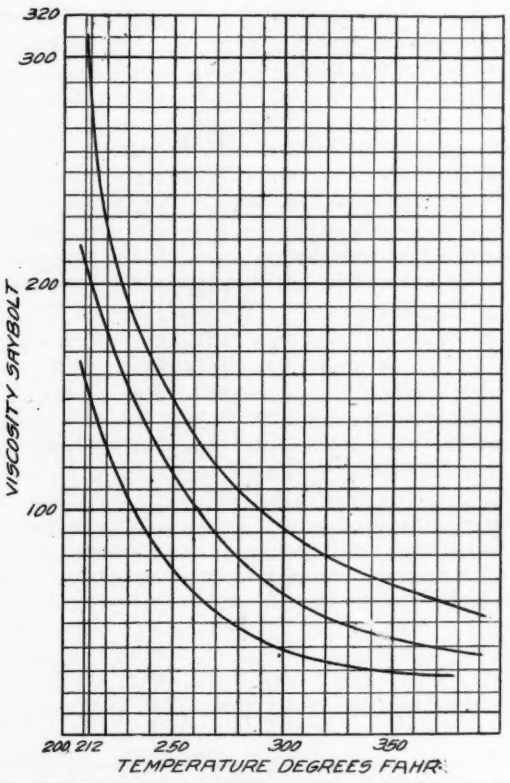
GAS ENGINE IGNITION, by E. B. Norris, R. K. Winning and W. C. Weaver; 174 pages, 209 illustrations; first edition; New York, 1916. Price, $1.50.

Responsive to the great demand on the part of the workers employed in factories and repair shops where required to install, adjust and repair ignition systems on internal combustion engines, for a systematic course of instruction along these lines, this volume has been developed. The division of the text matter which covers not only the underlying theory of the subject, but also detailed descriptions of the various types of ignition systems on the market at the present time, has been made with the idea of making uniform assignments of work for home study rather than of following any logical classification. And to accommodate the class of readers for which this volume is intended much of the theoretical matter contained therein is of necessity quite elementary in nature. Another indication of the desire on the part of the authors to make this volume of value to those responsible for the proper operation and maintenance of internal-combustion-engine ignition systems is the great amount of space devoted to the description of those systems which, while still in daily use, are

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

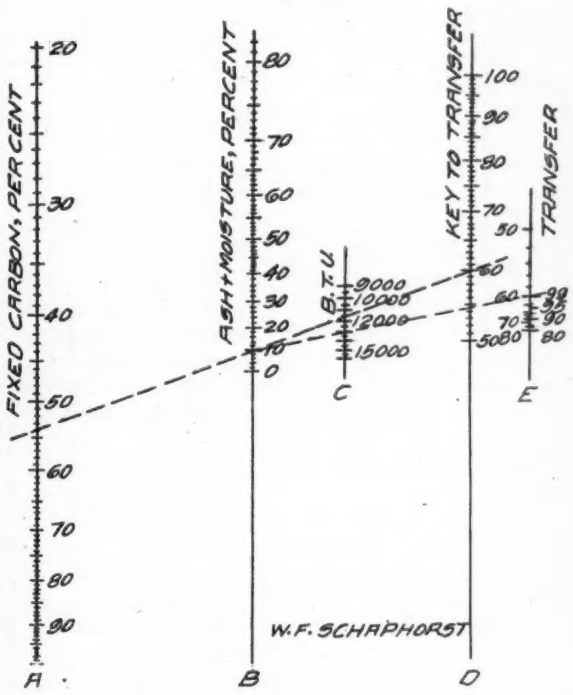
PRACTICAL ENGINEER

VARIATION OF VISCOSITY OF OILS WITH TEMPERATURE



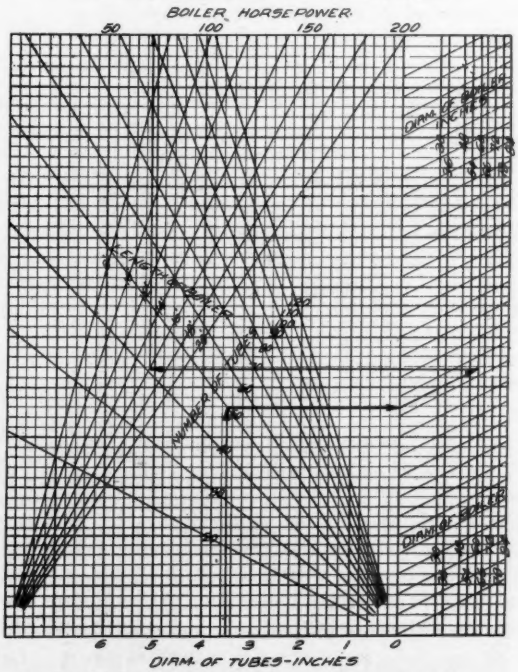
PRACTICAL ENGINEER

CHART FOR CALCULATING HEAT VALUE OF COAL FROM PROXIMATE ANALYSIS



PRACTICAL ENGINEER

CHART FOR CALCULATING APPROXIMATE HORSEPOWER OF RETURN TUBULAR BOILERS. BASED ON 12 SQ. FT. OF HEATING SURFACE PER HORSEPOWER

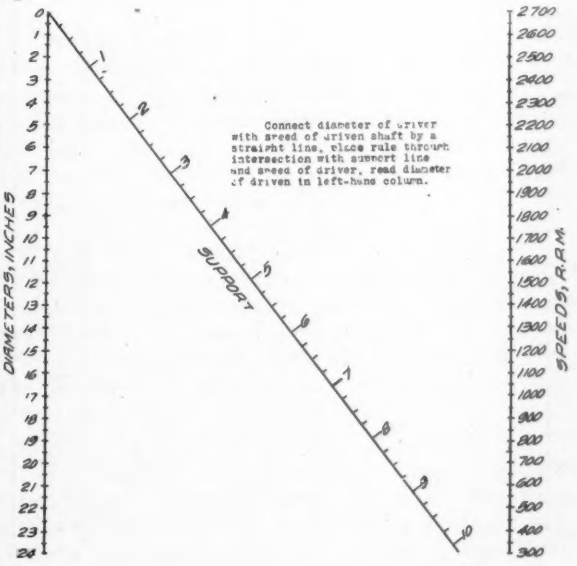


Directions: Enter chart at bottom scale indicating diameter of tubes, trace vertically up to diagonal representing number of tubes, then horizontally to right and along diagonal transfer lines to vertical line representing diameter of boiler, then horizontally to the left to diagonal representing length of boiler, then vertically up to horsepower of boiler.

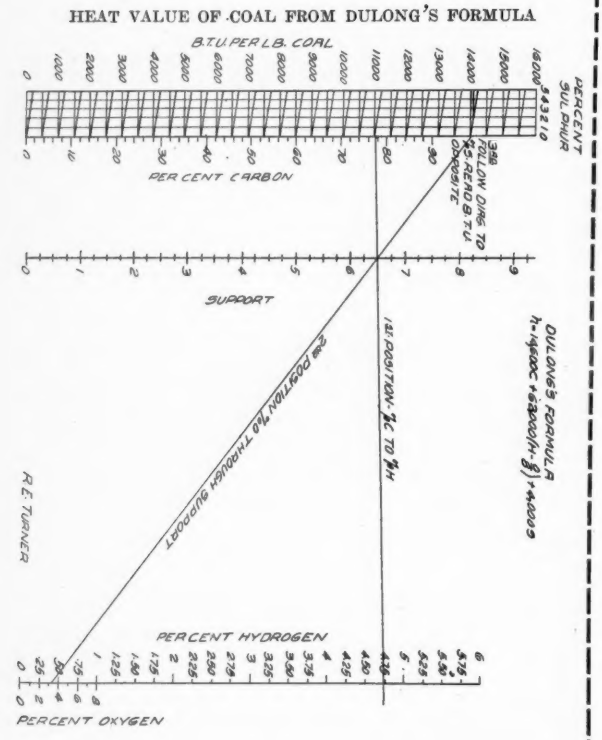
PRACTICAL ENGINEER

CHART FOR FINDING PULLEY DIAMETERS

Range—Diameters 1 in. to 24 in., Speed 300 to 2700 r.p.m.


DIAMETERS, INCHES
SPEEDS, R.P.M.
SUPPORT
Connect diameter of driver with speed of driven shaft by a straight line, close rule through intersection with support line and speed of driver, read diameter of driven in left-hand column.

HEAT VALUE OF COAL FROM DULONG'S FORMULA



LUBRICATION CHART

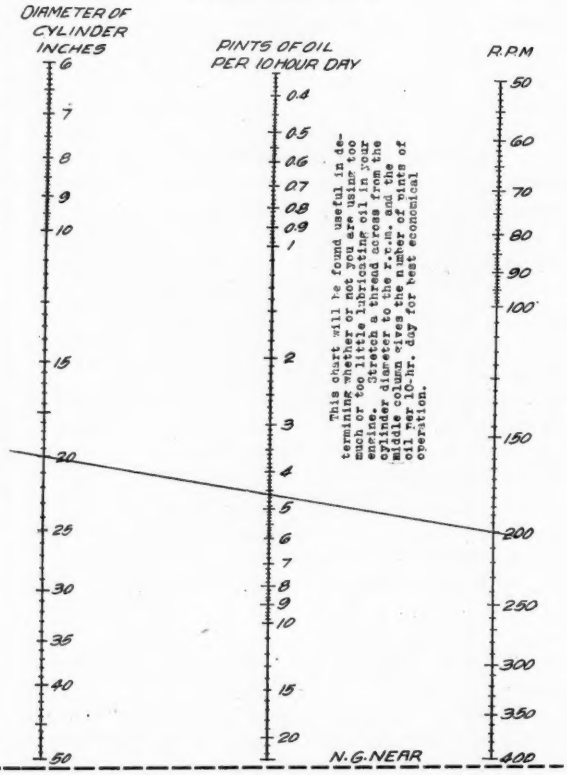
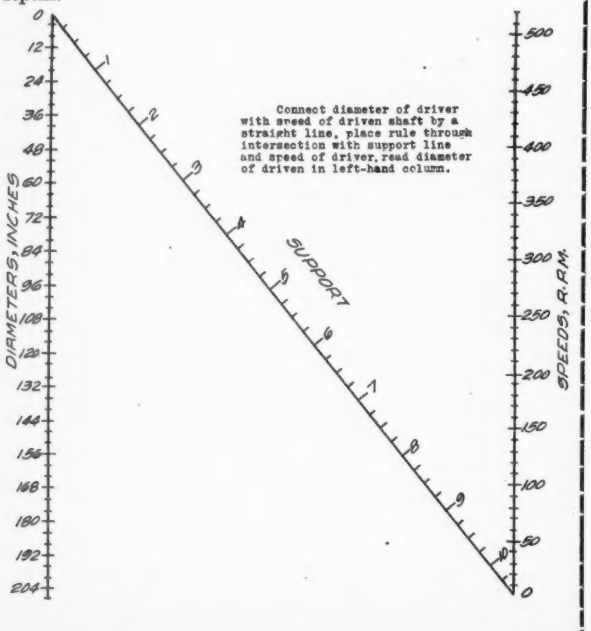

DIAMETER OF CYLINDER INCHES
PINTS OF OIL PER 10 HOUR DAY
R.P.M
This chart will be found useful in determining whether or not you are using too much or too little lubricating oil in your engine. Stretch a thread across from the cylinder diameter to the r.p.m. and the middle column gives the number of pints of oil per 10-hr. day for best economical operation.
N.G. NEAR

CHART FOR FINDING PULLEY DIAMETERS

Range—Diameters 12 in. to 204 in., Speeds 0 to 500 r.p.m.


DIAMETERS, INCHES
SPEEDS, R.P.M.
SUPPORT
Connect diameter of driver with speed of driven shaft by a straight line, place rule through intersection with support line and speed of driver, read diameter of driven in left-hand column.

NET AREAS OF SEGMENT OF BOILER HEAD TO BE STAYED

Height from Tubes to Shell.	Diameter of Boiler.											
	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"
	Area to be Stayed, in Square Inches.											
8"	28	33	37	40	43	47	51	53	55	58	60	63	65
8½"	35	41	46	51	55	59	63	66	70	74	76	80	82
9"	42	49	56	62	67	72	76	80	84	89	92	95	98
9½"	50	58	66	70	80	86	91	96	101	105	111	116	119
10"	57	68	77	85	93	99	106	112	117	123	129	132	137
10½"	66	78	89	98	107	114	123	131	135	142	147	153	160
11"	74	88	100	111	121	130	138	147	155	161	169	174	183
11½"	83	99	112	124	137	146	156	165	173	181	189	196	204
12"	91	109	125	139	151	163	174	184	194	208	213	219	230
12½"	—	120	138	153	167	180	193	204	216	224	234	243	252
13"	—	132	151	168	183	197	211	224	235	247	256	267	279
13½"	—	143	164	182	200	216	230	246	258	270	282	288	302
14"	—	155	178	199	217	234	250	266	280	294	305	319	331
14½"	—	167	192	215	235	254	271	287	303	318	333	345	360
15"	—	178	206	231	252	273	291	309	326	343	357	372	388
15½"	—	—	220	247	271	291	312	330	350	368	382	400	417
16"	—	—	235	263	289	312	334	355	374	394	411	428	443
16½"	—	—	249	281	308	332	357	380	399	420	436	457	475
17"	—	—	264	297	326	353	378	402	423	447	467	486	506
17½"	—	—	—	314	345	374	400	426	449	473	494	516	536
18"	—	—	—	331	365	396	424	450	476	500	520	543	564
18½"	—	—	—	349	384	417	448	476	501	526	552	577	598
19"	—	—	—	366	404	439	470	500	526	555	580	604	631
19½"	—	—	—	384	424	461	495	528	558	584	613	641	663
20"	—	—	—	401	444	483	519	552	583	618	642	667	699
20½"	—	—	—	—	464	505	543	578	613	643	676	706	729
21"	—	—	—	—	485	528	568	604	640	673	705	735	768
21½"	—	—	—	—	505	551	594	632	669	704	739	766	797
22"	—	—	—	—	526	574	618	658	697	734	769	800	835
22½"	—	—	—	—	—	597	642	687	726	765	800	835	867
23"	—	—	—	—	—	620	668	713	754	796	830	869	904
23½"	—	—	—	—	—	642	695	740	784	827	866	904	945
24"	—	—	—	—	—	667	719	768	814	859	897	939	978
24½"	—	—	—	—	—	689	745	797	843	892	934	975	1,018
25"	—	—	—	—	—	714	771	825	875	922	966	1,010	1,051
25½"	—	—	—	—	—	737	796	855	907	956	1,008	1,047	1,092
26"	—	—	—	—	—	761	824	882	936	987	1,035	1,083	1,126
26½"	—	—	—	—	—	—	850	909	968	1,024	1,072	1,120	1,167
27"	—	—	—	—	—	—	877	939	998	1,058	1,106	1,157	1,202
27½"	—	—	—	—	—	—	904	968	1,030	1,089	1,145	1,196	1,243
28"	—	—	—	—	—	—	930	997	1,060	1,120	1,177	1,232	1,279
28½"	—	—	—	—	—	—	—	1,028	1,092	1,157	1,211	1,270	1,321
29"	—	—	—	—	—	—	—	1,056	1,123	1,187	1,248	1,305	1,360
29½"	—	—	—	—	—	—	—	1,084	1,156	1,221	1,284	1,347	1,400
30"	—	—	—	—	—	—	—	1,115	1,187	1,255	1,321	1,382	1,442
30½"	—	—	—	—	—	—	—	—	1,218	1,290	1,358	1,424	1,480
31"	—	—	—	—	—	—	—	—	1,252	1,324	1,394	1,459	1,523
31½"	—	—	—	—	—	—	—	—	1,286	1,359	1,433	1,496	1,561
32"	—	—	—	—	—	—	—	—	1,317	1,394	1,467	1,538	1,605
32½"	—	—	—	—	—	—	—	—	—	1,430	1,508	1,575	1,650
33"	—	—	—	—	—	—	—	—	—	1,465	1,542	1,617	1,687
33½"	—	—	—	—	—	—	—	—	—	1,500	1,578	1,655	1,733
34"	—	—	—	—	—	—	—	—	—	1,536	1,617	1,695	1,770
34½"	—	—	—	—	—	—	—	—	—	—	1,654	1,736	1,816
35"	—	—	—	—	—	—	—	—	—	—	1,692	1,776	1,856
35½"	—	—	—	—	—	—	—	—	—	—	—	1,816	1,900
36"	—	—	—	—	—	—	—	—	—	—	—	1,857	1,941
36½"	—	—	—	—	—	—	—	—	—	—	—	—	1,984
37"	—	—	—	—	—	—	—	—	—	—	—	—	2,026

no longer manufactured. Of particular value to the practical man are the many clear cut illustrations and electrical wiring diagrams employed.

Chapter I is devoted to a classification of the various methods of ignition in use and a detailed outline of the make-and-break system; jump-spark battery systems and vibrating coils are taken up in the second chapter while the subject of non-vibrating coils is treated in the third. The following chapters—namely, from the fourth to the tenth, inclusive,—cover the subjects of batteries, low-tension armature-type magneto, oscillator magnetos, inductor magnetos, low-tension jump-spark ignition, high-tension magnetos, direct-current generators and brief descriptions of miscellaneous types of ignition systems.

How to Make Low-Pressure Transformers, third edition, by F. E. Austin, 5 by 7 in., 22 pages, illustrated; Hanover, N. H., 1916. Price, 40 cts.

This book is an enlargement of the second edition, the added material giving the reader the necessary information for making transformers with different specifications from that of which the detailed construction is described. The book is written primarily for experimenters, students and amateurs desiring to use alternating current at low voltage, the source being the ordinary 110-volt lighting system, for operating low-voltage tungsten lamps, ringing bells, operating small d.c. series motors used on fans or small electric cars, sparking devices for gasoline engines, small arc lights and a variety of other uses. Those desiring complete instructions for making such a transformer will find this book a great help.

Applied Electricity for Practical Men, by Arthur J. Rowland; 375 pages, 323 illustrations; first edition; New York, 1916. Price, $2.

The practical electrical worker who seeks a greater knowledge of his trade and who is unacquainted with mathematics and the sciences requires a text book in which all superficial and useless matter has been eliminated and yet embodying sufficient theory whereby he may understand the practical application of principles involved. As this volume has been in the process of making during 20 yr. of experience in teaching applied electricity to practical electrical workers, its value to the man whose daily work brings him into direct contact with electrical machinery and apparatus is quite apparent. It does not touch problems of design and the principles stated and the explanations of apparatus which are offered are only such as are necessary in order to present essential elements.

The many illustrations employed act as a further aid to a clear understanding of the text, while the set of problems found at the end of each chapter should serve to impress the subject matter upon the mind of the student.

Fundamental principles, electromotive force and Ohm's Law, magnets and magnetic flux are subjects taken up in the first 3 chapters; direct-current dynamos, drum armatures, multipolar machines, electric heating, electric power, direct-current systems of distribution and motors are considered in Chapters IV to IX, inclusive. The remaining 9 chapters are devoted to alternating-current machinery and apparatus, storage batteries, electric lighting and wiring.

Catalog Notes

INGERSOLL-RAND CO., 11 Broadway, New York City, has issued the following bulletins, copies of which will be sent free on application to the New York or any Branch Office:

Form 8311, 16 pages, 6 by 9 in., on "Little David" Pneumatic Riveting Hammers, inside trigger pattern. These hammers are offered in 6 sizes, the dimensions and specifications of which are listed in the descriptive table in the catalog. An important feature of this tool is the rivet set retainer designed to meet the regulations and requirements of the safety appliance laws enacted in the various states.

Form 3130, 24 pages, 6 by 9 in., on Class ER-1 power driven single stage straight line air compressors. Machines are built in various sizes from 6 to 12 in. stroke with a piston displacement capacity of 52 to 955 cu. ft. per minute and are equipped with the Ingersoll Rogler type of air valve. The catalog is illustrated to show the complete machine and all essential details.

GENERAL ELECTRIC CO. has issued the following among recent bulletins:

Bulletine No. 46,101A, Type P Demand Meter, a device designed for use in connection with a watthour meter whereby a printed record is made of the total energy consumption as registered by the watthour meter, also making a simultaneous record of the time of day at which the various amounts of energy were consumed.

Bulletin No. 46,103A, Type M Demand Meters, for use in connection with a watthour meter to obtain the maximum demand.

Bulletin No. 46,104A, Type G Demand Meter, for use with watthour meters, providing a graphic record which shows the average demand during every interval of the day, the time of day and day of the week each amount of energy is delivered.

Bulletin No. 48,320 on speed-regulating rheostats and panels for direct-current motors.

WATER CONTROLLING APPARATUS catalog No. 30, Section WCA, listing valves, gates, hoists and accessories, a comprehensive catalog covering water controlling apparatus as constantly required in connection with canals, penstocks, flumes, irrigation and sewerage improvements, was recently issued by Rodney Hunt Machine Co., Orange, Mass.

STOW MANUFACTURING CO., Binghamton, N. Y., is sending out a miniature reproduction of its Bulletin No. 102, which gives, in convenient size, all the information in the larger catalog. While the booklet, which contains over 100 pages, is only 3 by 5 in., the type is clear and readable and all illustrations are distinct.

TWO RECENT publications of the Armstrong Cork & Insulation Co., of Pittsburgh, Pa., are "Nonpareil Corkboard Insulation for Cold Storage Rooms," and "Fifteen Years on Brine Lines." Copies of these booklets will be supplied to any interested party upon request.

WIRE ROPE made by John A. Roebling's Sons Co., Trenton, N. J., is the subject of a new circular from that company.

FROM MAIN BELTING CO., of Philadelphia, we have just received one of the company's latest circulars, entitled "Man Service."

CROUSE-HINDS Imperial flood light projectors are described and illustrated, together with price lists, in Bulletin No. 301 lately received from Crouse-Hinds Co., Syracuse, N. Y.

A KEY to Higher Efficiency in the Boiler Plant, is the title of Bulletin No. 7 illustrating and describing the Blonck boiler efficiency meter manufactured by W. A. Blonck & Co., Fisher Bldg., Chicago.

ROTARY PUMPS are the subject of Bulletin 113 of The Goulds Mfg. Co., Seneca Falls, N. Y., including illustrations and description of a new line of rotary oil pumps for individual lubrication of machine tools.

SHEPARD Electric Crane & Hoist Co., Montour Falls, N. Y., recently issued Bulletin M-1, relating to single-speed, floor-operated d.c. electric hoists in sizes of ¼, ½ and 1 ton.

INSTALLATION, OPERATION and construction of Lunkenheimer non-return safety boiler stop valves are discussed in a booklet from The Lunkenheimer Co., of Cincinnati, O.

SINGLE AND MULTISTAGE steam turbines and reduction gears made by Moore Steam Turbine Corporation, Wellsville, N. Y., are described and illustrated in Bulletin No. 1, recently issued by the company.

ENGINEERING DEPARTMENT Bulletin 8F of National Lamp Works of General Electric Co., superseding Bulletin 8E and presenting the essential operating characteristics of miniature Mazda lamps, was lately received.

McCORD FORCE FEED lubricator for steam, gas and oil engines, Diesel engines, air and ammonia compressors, and special lubricators for steam shovels and dredges, marine, gasoline and gas tractor engines, are described and illustrated in Catalog No. 13 of McCord Mfg. Co., Detroit, Mich.

CATALOG N-3 of The Lagonda Mfg. Co., Springfield, O., explains the function of the Lagonda automatic cutoff valve, illustrates a number of types and describes the U. S. Government tests on the Lagonda valve. Lagonda multiple water strainer, boiler tube cleaners and other Lagonda boiler room specialties are also illustrated.

RECENT BULLETINS of The Automatic Reclosing Circuit Breaker Co., of Columbus, O., have been received as follows: Bulletin No. 10, discussing advantages of automatic reclosing circuit breakers; No. 11, on theory and operation; No. 12, 13 and 14, on three different types of automatic reclosing circuit breakers; No. 20, entitled, Important Considerations in the Protection of Individual Motor Circuits; No. 8, on relays for use with automatic reclosing circuit breakers on direct-current circuits.

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WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer. 537 S. Dearborn St., Chicago, Ill. tf.

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WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

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SPECIALS—16 x 36 Fishkill Corliss engine, $600; 10 x 24 Hewes-Phillips, $375; 15 x 14 Ideal auto, $400; 72 x 18 HRT boiler, 125-lb., $600; 40 K.W Sturtevant 125-volt dir. con. set, $750; 75 K.W. G. E. 250-volt dir. con. Harrisburg s.c. engine, $1200. Power Machinery Exchange, Inc., 1 Montgomery St., Jersey City, N. J. 12-15-1

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GAS ENGINE FOR SALE—One 15-hp. 2-cylinder Westinghouse gas engine for sale in good condition. No reasonable offer refused. Correspond with E. B. Latham & Co., 4 Murray St., New York City. 10-15-6

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ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

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Under the above title, Advertising and Selling Magazine published an editorial that shows the trend of the trade and technical press and the exact relations existing between the publishers and their constituencies. It is a comparative study induced by the recent Convention of the Associated Business Papers. Read the following extract from this editorial:

"Now the publishers, large and small, know that if, as a class, they view industry broadly, and stand for constructive policies, broad in scope, thoroughly sound in principle, predicated upon the best of our industrial experience and on a far and clear look into the future, they can exercise a larger influence on our industries than any other agency. Formerly individual papers made a breach here and there in the line of iudustrial and trade indifference. Now, under the stimulus of the same broad ultimate aim—the industrial and business welfare of the country—they are advancing on a solid front.

There was also, throughout the convention, a very apparent suppression of self-interest. Ways of increasing profits received little consideration, compared with the time devoted to means of serving the respective fields. That characterizes the convention as a great one, whether considered from the publisher's standpoint or from that of the general public.

Moreover, the paper that sets itself persistently and consistently to serve the whole industry is creating the best possible medium for the advertiser. Such a policy creates prestige and power—the necessary foundation of a medium that is to get and hold the buying units in its field.

But the result for service is more than multiplied by the number of papers in a particular field, when they all work together to develop that certain industry.

Whether viewed broadly, therefore, from the standpoint of industry, or narrowly from the standpoint of those who contemplate using the business papers as advertising media, the Convention of the Associated Business Papers was of first importance."